NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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ADVANCE RESTRICTED REPORT

AN INVESTIGATION OF A THERMAL ICE-PREVENTION SYSTEM

FOR A C-46 CARGO AIRPLANE

IV - RESULTS OF FLIGHT TESTS IN DRY-AIR

AND NATURAL-ICING CONDITIONS

By James Selna, Carr B. Neel, Jr., and E. Lewis Zeiller

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Moffett Field, California

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SUMMARY

As part of a comprehensive investigation of a thermal ice-prevention system for a C-46 cargo airplane, flight tests in dry-air and natural-icing conditions have been conducted by the Ames Aeronautical Laboratory at Moffett Field, Calif., and at the Air Technical Service Command Ice Research Base, Minneapolis, Minn. The research was undertaken to determine the effectiveness of the C-46 airplane ice-prevention system and to continue the development of thermal ice-prevention equipment.

Extensive thermal data were recorded during all flight tests and numerous photographs were taken during, and subsequent to, flight in natural-icing conditions. The results of these flight-tests indicated that the ice protection afforded the airplane by the thermal ice-prevention system prevented the loss of aerodynamic efficiency of the wings and the empennage and maintained visibility through the windshields during flight in all natural-icing conditions encountered. The skin temperature rise over the wing and empennage heated leading edges exceeded the temperature rise calculated in the design analysis, which indicates that the method of analysis utilized is either inaccurate or incomplete. It can be concluded from the results of the flight tests that a thermal ice-prevention system affording protection for the wings, the empennage, and the windshields of the C-46 airplane can be constructed that will enable the planning of safe flight operations into known icing conditions without the loss of aerodynamic or functional efficiency.

INTRODUCTION

This report is the fourth of a series which describes a comprehensive investigation of a thermal ice-prevention system for a C-46 cargo airplane. The first three reports of the series (references 1, 2, and 3) describe, respectively, the design analysis of the thermal ice-prevention system, the design and construction of the heat exchangers employed, and the construction and instrumentation of the complete system. This report presents the results of extensive flight tests of the C-46 airplane equipped with the thermal ice-prevention system in both dry-air and natural-icing conditions.

The research described in this series of reports constitutes a part of a general research program designed to investigate the practicability of utilizing the waste heat of airplane-engine exhaust gases to heat those surfaces of an airplane that require protection from the formation of ice in order to provide safe and efficient operation of the airplane in natural-icing conditions. The development of effective equipment under this program has been demonstrated by the flight testing, in natural-icing conditions, of thermal ice-prevention systems in a Lockheed 12A airplane (reference 4), in a Consolidated B-24 airplane (reference 5), and in a Boeing B-17 airplane (reference 6). Adequate protection was realized by these systems and their use permitted the safe operation of the respective airplanes in many icing conditions.

The thermal ice-prevention system for the C-46 airplane was designed to permit extensive and safe flights in natural-icing conditions without the loss of operational efficiency associated with the formation of ice upon an airplane's wings, empennage, and windshield. This system represents a refinement of earlier equipment and has been designed to facilitate modifications to the production version of the airplane. The purpose of the investigation reported herein was to determine the effectiveness of the thermal ice-prevention system in preventing the formation of ice upon the protected surfaces of the airplane during flight in natural-icing conditions. The investigation includes flight tests in dry air to establish the thermal characteristics of the system and to determine the variation of these characteristics with change in altitude and engine power conditions, as well as flights in natural-icing conditions to obtain observational, photographic, and thermal data, in as many different types of icing conditions as possible. Data obtained from such flights provide criteria for future designs, test the validity of the design method utilized, and provide experimental evidence of the protection afforded in natural-icing conditions by the thermal ice-prevention system of the C-46 airplane.

This research was conducted at the request of the Air Technical Service Command of the U. S. Army Air Forces. The flight tests were made at Ames Laboratory, Moffett Field, Calif., and at the Air Technical Service Command Ice Research Base, Minneapolis, Minn., with the cooperation of the U. S. Weather Bureau and the Curtiss-Wright Corporation.

DESCRIPTION OF EQUIPMENT

The thermal ice-prevention equipment installed in the C-46 airplane (Army number 41-12293) shown in figure 1 is completely described in references 1, 2, and 3. Detailed information on the design analysis of the thermal ice-prevention equipment, the general arrangement of which is shown in figure 2, is presented in reference 1. Reference 2 completely describes the design and construction details of the exhaust-gas-to-air heat exchangers employed in the system. Details of the construction of the thermal ice-prevention system and of the instrumentation provided to evaluate the performance of the system are contained in reference 3. Typical thermocouple and pressure-orifice installations are shown in figure 3, and an index to the instrumentation is presented in figure 4.

The following additions and changes were made to the thermal ice-prevention system described in reference 3 prior to, or during, the flight tests reported herein:

1. The secondary air inlet at the nose of the airplane was closed and holes were made in the sides of the secondary heat-exchanger air-inlet duct to enable cabin air to enter the secondary exchanger.

2. All secondary heat-exchanger air outlets were closed with the exception of the outlet directing air to the pilot's and copilot's windshields.

3. The total-pressure heads installed in the air-inlet scoops were removed after flight 5 since they would collect ice when the airplane was subjected to operation in natural-icing conditions.

4. The valves controlling the distribution of heated air in the fuselage ducts were set and wired in place.

5. The copilot's and observer's airspeed indicators were connected to fuselage static vents. This installation was made after flight 28.

6. A glass-stem thermometer for the measurement of ambient-air temperature was installed outside the left window panel at station 286 after flight 30.

7. The service-type antennas were replaced after flight 30 by 1/16-inch rubber-covered steel-cable antennas.

TESTS

During all flight tests, the airplane was flown at a gross weight of 40,000 pounds under operating conditions specified by the C-46 aircraft manual of Northwest Airlines, Inc. These operating conditions are listed in table I.

Preliminary flight tests under dry-air conditions were conducted at Ames Laboratory to assure that the equipment would operate safely and satisfactorily. During these preliminary flights, total-pressure measurements were made in the heat-exchanger air-inlet scoops.

Tests of the equipment, during which most of the flight data were taken, were conducted at the Air Technical Service Command Ice Research Base, Minneapolis, Minn. Complete dry-air thermal data were taken at altitudes to 18,000 feet at the climb, the descent, and the 1900-rpm cruise power conditions. Limited dry-air thermal data were also taken at the maximum-range cruise and the 2050-rpm cruise power conditions at several altitudes to establish the effect of engine power on the performance of the thermal ice-prevention system. Equilibrium conditions were established for the various tests by holding the engine power conditions constant for a sufficient time previous to recording data.

Flights were made in natural-icing conditions whenever such conditions were available during the period from January 10 to April 1, 1944, in the 500-mile-radius area surrounding Minneapolis, Minn. Flight data in natural-icing conditions were taken at the 1900-rpm cruise condition and, to a limited extent, at the maximum-range cruise condition. The thermal ice-prevention system was operated at full capacity and reduced-heated-air-flow rates. Flight tests in natural-icing conditions were conducted in the regions and at the altitudes of maximum icing. Data were taken when conditions were of sufficient extent and intensity to obtain a complete set of readings and observations. During these flights, periodic inspections of the ice accretions on surfaces of the airplane were made, and the entire airplane was inspected for ice formations after each flight. Some photographic data were taken during flight and after landing.

The extent to which frost was removed from the heated surfaces when the airplane was at rest on the ground was observed. The extent to which ice was removed during the take-off operation was also observed. For these tests, artificial-icing conditions which simulated a freezing rain were provided by the use of a water spray. The artificial ice was applied in 2-foot strips 1/16 inch thick to stations 159 of the outboard wing panels. The tests were conducted on an overcast day to reduce the solar-radiation effects.

Surface-thermocouple data were taken at the 1900-rpm cruise condition at various altitudes in natural-icing conditions and in dry air. The indications of the surface thermocouples installed at station 159 of the left wing outer panel and those of the corresponding washer thermocouples were observed on a Brown potentiometer.

The heated windshields were operated with only external primary heated-air flow directed to the pilot's and copilot's windshields during most of the flights. Limited data were taken with the use of both the external primary heated air and the internal secondary air directed to the windshields.

The heat exchangers employed by the thermal ice-prevention system were removed, sandblasted, and inspected for deterioration after a total of 100 hours and 173 hours of flight testing.

RESULTS AND DISCUSSION

The performance of the C-46 airplane thermal ice-prevention system is presented in tables II, III, IV, V, and VI. Table II presents the dry-air test results for the level-flight conditions and table III presents the dry-air climb and descent test results. The test results obtained in natural-icing conditions are presented in tables IV and V for full- and reduced-heated-air-flow rates, respectively. The thermal results of the secondary heat exchanger and the pilot's and copilot's windshield tests are presented in table VI. Tables II, III, IV, and V are each arranged in 17 similar parts. The general flight data and calculated heat-flow results are in the first three parts. The remaining parts present the temperature and heated-air-flow-rate data together with sketches of the instrumented sections of the C-46 thermal ice-prevention system. The ambient-air temperature is provided for each test throughout the parts of each table in order that temperature-rise data may be readily evaluated. The ambient-air temperatures given are not corrected for the effects of kinetic heating.

The severity of icing (light, moderate, and heavy) noted in part 1 of tables IV and V was arbitrarily chosen to provide a means for comparing flights. The light-icing conditions would probably permit flight without any means of ice protection. The heavy-icing conditions would probably cause an unprotected airplane to descend in a short time. The intermediate natural-icing conditions are those designated as moderate.

Measurements of the total pressures in the air-inlet scoops of the left nacelle heat-exchanger installations were made in flight. The airplane was flown at an indicated airspeed of 155 miles per hour at 6000 feet pressure altitude with the engines operating at 2000 rpm. The pressure distribution in the inlet scoops was uniform. The average total pressures were 2.2 and 1.5 inches of water above free-stream total pressure for the outboard and inboard heat-exchanger inlet scoops, respectively.

Table VII presents typical comparisons of the surface-thermocouple and washer-thermocouple data taken for the left wing outer-panel station 159. No data are presented for the region aft of 7-percent chord where the surface thermocouples and washer thermocouples indicated the same temperature, within the accuracy of measurement.

The thermal ice-prevention system was operated 173 hours in flight, 30 hours of which were in natural-icing conditions. The system offered satisfactory ice protection to the wings, the empennage, and the windshields in all the natural-icing conditions encountered. The ice accumulations on the heated surfaces were slight and did not noticeably affect the operational performance of the airplane. The skin-temperature rises of the heated surfaces realized in natural-icing conditions were lower than those obtained in comparable dry-air flight conditions. A comparison of the moderate- and heavy-icing conditions of table IV with comparable dry-air data of table II indicates that the wing outer-panel temperature at the 0-percent-chord points realized in these icing conditions average approximately 65 percent of those obtained in dry air for comparable flight conditions. The experimental skin-temperature rises during tests at approximately the design conditions (flight 61, run 5) greatly exceed those specified in the design analysis (reference 1).

Wing Outer Panel

The thermal ice-prevention system essentially prevented the formation of ice on the wing outer panels when operated with full-heated-air-flow rates (table IV, pts. 5 to 10). The full-heated-air-flow rates, in natural-icing conditions, provided average heat flows through the left-wing leading edge (table IV, pt. 3) of approximately 1100 to approximately 1800 Btu per hour per square foot of double-skin leading-edge surface, and the average 0-percent-chord temperatures above ambient (table IV, pt. 3) ranged from 66° to 113° F. The lowest 0-percent-chord temperature recorded was 82° F at station 380. Slight runback, defined as the freezing of water which runs back from the leading edges, was noted on flight 34 in the 30- to 35-percent-chord region of the right-wing outer panel. These accretions were intermittently removed with constant wing outer-panel heating.

During flight 49, a severe inclement-weather condition was encountered over the Sierra Nevada Mountains between Sacremento, Calif., and Salt Lake City, Utah. This condition can best be described as a very heavy snow combined with a heavy natural-icing condition. Snow and ice formed in the stagnation-pressure region along the entire wing span and remained for approximately 10 minutes. The thermal data of flight 49, run 1, were taken during this period and indicate that the left-wing outer-panel 0-percent-chord skin temperature was approximately 100° F. Evidently, the rate at which the snow and ice formed and the low ambient-air temperature (6° F) were factors that permitted the snow and ice to accumulate.

The reduced-heat tests (table V, pts. 5 to 10) define the effects of decreasing the heat flow to the wing outer panel. The average heat flows through the left-wing leading edge (table V, pt. 3) during these tests ranged from 240 to 830 Btu per hour per square foot of double-skin leading-edge surface, and the average 0-percent-chord temperatures above ambient (table V, pt. 3) ranged from about 40° to about 95° F. The lowest 0-percent-chord temperature recorded was 50° F at station 380.

Run 3 of flight 29 was taken after the left-wing outer-panel leading edge had been allowed to collect a band of ice throughout the span, similar to that shown in figure 5, and the heated-air-flow rate was slowly increased until the ice was removed with runback taking place. After the test, the heated-air-flow rate was increased to full and the runback was removed. The average heat flow through the wing leading edge during this test was 250 Btu per hour per square foot of double-skin leading-edge surface, and the resulting average 0-percent-chord temperature above ambient was 40° F. The lowest 0-percent-chord temperature recorded was 58° F at station 380. During flight 41, run 3 was taken after the heated-air-flow rate to the left-wing outer panel was decreased until the protection was considered marginal. The average heat flow through the wing leading edge was 440 Btu per hour per square foot of double-skin leading-edge surface, and the resulting 0-percent-chord leading-edge temperature above ambient was 48° F. The lowest 0-percent-chord temperature recorded was 50° F at station 380. Small accretions of ice had collected on the left-wing outer panel 2 or 3 inches forward of the front spar from midspan outboard. The thermal ice-prevention system during the other reduced-heated-air-flow-rate tests presented in table IV, parts 5 to 10 apparently supplied the same protection to the wing outer panels as did the full-heated-air-flow-rate tests taken in the same natural-icing conditions.

Surface-thermocouple and washer-thermocouple data taken for station 159 of the left-wing outer panel differed considerably (table VII). The temperatures indicated by washer-thermocouple installations S19, S20, and S23 were approximately 23°, 30°, and 21° F higher, respectively, than the corresponding surface-thermocouple installations SC1, SC2, and SC3. The construction of the thermal ice-prevention system at station 159 is shown in figure 6. The heated air is directed by the nose-rib liner along the inner surface of the skin where the washer thermocouples were installed. Thus the washer thermocouples in the region forward of the baffle plate were subject to considerable fin heat-transfer effect from the heated air and are evidently in error by the temperature differences indicated. These given values of temperature error apply strictly to the undersurface of the skin at station 159 of the left-wing outer panel. In general, however, a similar washer-thermocouple error would exist in the temperature measurements for both the upper and lower surfaces throughout the wing outer panel to station 292 where the nose-rib liner ends. The remaining leading edges of the thermal ice-prevention system contain no nose-rib liners; nevertheless the washer thermocouples throughout the heated surfaces forward of the baffle plates are also probably in considerable error. The given values of temperature differences apply only for the full-heated-air-flow rates. The reduced-heated-air-flow-rate data, however, would probably not be subject to as great a temperature difference between the corresponding washer- and surface-thermocouple indications.

The temperatures of the primary structure of the left-wing outer panel were measured on the front spar, the stringers, and the nose ribs at stations 24 and 159 (pts. 6 and 8, tables II, III, IV, and V.) The indicated temperatures of the front spar and the stringers were never over 111° F. The highest nose-rib temperature measured was 294° F which is considered high but not excessive at this region of the wing structure.

A comparison of the experimental test results and the analytical calculations of reference 1 introduces the opportunity for considering the heat-transfer relationships discussed in the analysis (reference 1) and the indications of actual heat-transfer phenomena resulting during the tests. A graphical comparison of experimental and analytical air and skin temperatures above ambient-air temperature is presented, for the four wing outer-panel stations analyzed, in figures 7, 8, 9, and 10. The test results are taken from data recorded during flight 61, run 5 (table II), which approximated the analytical design conditions. During this run the total heated-air-flow rate was 4015 pounds per hour to the left-wing outer panel, as compared with an analytic flow rate of 4130 pounds per hour, and the temperatures of the air entering the corrugations agreed closely with the assumed air temperatures. The air-temperature rise through the exchanger was 369° F (69° F above the temperature rise of the analysis), resulting in a thermal output of 362,000 Btu per hour. This is 20 percent higher than the anticipated value of 301,000 Btu per hour. Nevertheless, the air-temperature change from the exchanger outlet to the corrugation inlets was sufficient to give approximately the corrugation air-inlet temperatures of the analysis at all but one station (380). Furthermore, the temperature of the air entering the corrugation at station 380 was higher than at any other station. These two facts, together with an inspection of the leading-edge construction (fig. 6), indicate that some of the heat was transferred from the air in passing between the nose-rib liner and the corrugations to the corrugation inner surfaces, and ultimately to the outer skin, causing a decrease in heated-air temperature from the leading-edge duct to the corrugation inlets. Since the nose-rib liner ends at station 292, this effect would not prevail at station 380, and the temperature of the air at the corrugation entrance would be substantially the same as in the leading-edge duct at this point.

The indicated air-temperature drops through the corrugations at stations 84, 159, and 290 recorded during the test flight were in fairly close agreement with the calculated values from the analysis, but the air-temperature change through the corrugations at station 380 was considerably greater than calculated. These results substantiate the previous conclusions that a considerable amount of heat was transferred from the air prior to entering the corrugations in the region of the nose-rib liner. Thus, at all points the total heat transferred from the heated air to the skin was higher than calculated. It should be realized, then, that the average heat flow through the heated surface, shown in table II and calculated from the air-temperature change through the corrugations, is not the total heat flow through the surface. Further evidence of these facts is exemplified in the results of the skin-temperature indications from the tests. As previously stated, the indicated skin temperatures forward of the baffle plate are believed to read 20° to 30° F high on the basis of a comparison of the temperatures indicated by the standard washer-therocouple installation and the assumed correct surface thermocouples at station 159. Therefore the indicated skin-temperature rises shown in figures 7, 8, 9, and 10 were corrected by approximately 25° F in the region forward of the baffle plate. The average corrected skin-temperature rises obtained from the flight-test data were approximately 60° F higher than calculated, indicating that a greater amount of heat had been transferred from the heated air to the skin than had been calculated in the analysis. Conduction and radiation effects from the corrugation walls to the heated surfaces were conservatively neglected in the analysis, and this fact probably accounts in part for the lower calculated skin temperatures. Laboratory experiments have shown the conduction effect to be a substantial part of the resultant heat transfer within a corrugation (reference 7).

The rapid decrease in skin-temperature rise shown in figures 7, 8, 9, and 10 in the region immediately aft of the baffle plate is probably a result of two effects. The first and most important effect is the location of the transition region. In the analysis, the point of transition from laminar to turbulent flow was calculated to be well aft of the heated region. This was for an aerodynamically smooth wing. It is indicated from the decrease in skin-temperature rise in the region from about 5- to 10-percent chord that transition actually occurred in this area. Such a condition could conceivably prevail in view of the relatively rough surface and waviness of the wing.

The second effect is the location of the baffle plate. Aft of this point, the skin received no heat from the air in the D-duct before entering the corrugations. For this reason, the surface temperature would tend to decrease aft of about 5 percent chord.

The effect of the propeller slipstream on the transition point is believed to be represented by the skin temperatures given in table II, part 6 for wing outer-panel station 24 which is located just aft of the left propeller. The recorded temperatures presented in table II, part 6, show a sharp decrease in skin temperature aft of the stagnation region, from about 160° F (corrected) at the leading edge to 120° F (corrected) at 3-percent chord, indicating that transition probably occurred just aft of the stagnation point.

Wing Tips

The protection relized at the wing tips was not sufficient to prevent ice in the heavy-icing condition and in several of the moderate-icing conditions encountered. The most common ice formations in this region were on the extreme wing-tip leading edges. During the heavy-icing condition, flight 50, and during the reduced-heat tests in the heavy-icing, and in some of the moderate-icing conditions, the formation of ice was continuous along the leading edge from the wing tips to the wing-tip splices. No photographic data were taken of these ice accumulations, since they could not be adequately photographed in flight, and since they never remained on the surface after landing. The temperature data given in part 11 of tables II, III, IV, and V indicate that the wing-tip leading edges were not adequately heated. The internal structure does not provide a sufficiently high heat-transfer coefficient at the leading edges of the wing tips.

Wing Center Panel

The wing center panels were for the most part adequately protected. A very small patch of ice was noted to accumulate on the flange of the heat-exchanger outlet-duct fairing where the ducting enters the center-panel wing leading edge. It was also noted that snow would pack on this flange. During some of the more severe icing conditions, slight accumulations of runback were noted to form on the upper surface of the wing center panel. The conditions of the wing center panels were the same as those of the wing outer panels during flight 49. Temperature data given in part 12 of tables II, III, IV, and V indicate that the protection was sufficient at all times. The temperature in natural-icing conditions at the 0-percent-chord leading edge, indicated at station 90, never dropped below 104° F, even during the reduced-heated-air-flow-rate tests. It is believed that a better design could be realized, however, by revising the heated-air corrugations so that the heated air enters the corrugations at the leading edge of the wing instead of at the underside end of the corrugations. No heated-air-flow rates to the instrumented center panel are given in the tables. The system was designed to provide this flow rate by subtracting the summation of venturi 7 and venturi 4 flow rates from the summation of venturi 2 and venturi 3 flow rates. The air leakage in the system, however, renders this method unreliable.

Horizontal Stabilizers

With the thermal ice-prevention system directing full-heated-air-flow rates to the horizontal stabilizers, ice formed on the leading edges of the stabilizer tips. The ice accumulations on the stabilizer tips were similar to those observed on the wing tips, and, in general, formed in the same manner in the same icing conditions. During flight 34 at the time data were taken, slight runback was noted on the underside of the right stabilizer panel at about 10 percent chord. No observations of the stabilizers were made during flight 49. The thermal data for the horizontal stabilizer (pts. 13, 14, and 15 of tables II, III, IV, and V) indicate that the temperatures realized were sufficient to prevent ice. No temperature measurements were made on the extreme stabilizer-tip leading edges where the formation of ice, previously noted, accumulated. The average heat flow through the stabilizer leading edge in natural-icing conditions ranged from about 1250 to about 2150 Btu per hour per square foot of double-skin leading-edge surface during the full-heated-air-flow-rate tests (table IV, pt. 3), and from about 700 to about 1400 Btu per hour per square foot of double-skin leading-edge surface during the reduced-heated-air-flow-rate tests (table V, pt. 3). The lowest 0-percent-chord temperature recorded for the stabilizer, exclusive of the tip, was 51° F at station 69 during the reduced-heated-air-flow-rate tests.

Vertical Fin

The entire surface of the vertical fin including the tip was clear of ice during both the full- and reduced-heated-air-flow-rate operations of the thermal ice-prevention system. The temperatures of the skin surfaces presented in parts 16 and 17 of tables II, III, IV, and V indicate that the quantity of heat supplied was more than adequate for complete protection in the test icing conditions. The average heat flows through the vertical-fin leading edge, in natural-icing conditions ranged from approximately 2700 to approximately 4600 Btu per hour per square foot of double-skin leading-edge surface during the full-heated-air-flow-rate tests (table IV, pt. 3), and from approximately 1600 to approximately 2900 Btu per hour per square foot of double-skin leading-edge surface during the reduced-heated-air-flow-rate tests (table V, pt. 3). The lowest 0-percent-chord temperature recorded was 81° F at station 205 during the reduced-heated-air-flow-rate tests.

Windshields

The pilot's and copilot's windshields were protected from ice accumulations in all the test natural-icing conditions. The external heating system offered thorough windshield ice prevention in all the natural-icing conditions except the heavy-icing condition encountered during flight 50. During this flight with only the external heating system in operation, the pilot's and copilot's windshields collected ice at a fast rate and the ice almost completely covered the windshields. After the windshields had collected ice, as shown in figure 11, the internal secondary air-heating system was placed in operation without inserting the double-panel windshields. Figure 12 shows the partial ice removal effected after 15 minutes. It was noted that when the double-panel windshields were inserted, the rate of ice removal was increased. The values given in table VI were taken during later flights and provide the thermal data for maximum protection which was never required to remove or prevent ice in any of the natural-icing conditions encountered.

These tests indicate that windshield ice prevention may be realized by the passage of heated air over the outer surface of the windshields. Before any design criteria can be established, however, investigations must be made of the relationships of the following: temperature and flow rate of the heated air delivered, temperature rise above ambient-air temperature of the outer surface of the windshield; pressure and temperature distribution of the heated air flowing in the windshield boundary layer, and area and shape of the windshield. An investigation of these relationships has been undertaken by Ames laboratory.

Ice-Removal Tests

In order to establish the effectiveness of the system in removing ice on the heated surfaces prior to take-off, tests were conducted in which artificial ice was applied to stations 159 of the wing outer panels as shown in figure 13. The tests were conducted at a ground ambient-air temperature of 6° F. After the engines had been started and normal engine warm-up had taken place for 5 minutes, water drops started forming on the left-side ice application. While the airplane was taxied out to the runway for take-off, water drops were forming on both the strips of ice, but no substantial change in over-all appearance was evident. Take-off was conducted 14 minutes after the engines had been started and ice removal immediately began to take place. The leading edges of stations 159 were clear of ice, as shown in figure 14, before the airplane left the ground.

Natural frost was removed from the wings, the empennage, and the windshields of the airplane on cold mornings (-10° to 15° F) while the airplane was warmed-up for flight. The frost on these heated surfaces could be almost completely removed after conducting engine warm-up for not more than 1/2 hour.

During flight, in many of the natural-icing conditions, the leading edge of the left-wing outer panel was allowed to collect ice similar to that shown in figure 5. The outboard panel was always cleared of the ice accumulations in less than 1 minute after full-heated-air-flow rate to the left outer wing was employed.

The frost-removal and artificial-ice-removal tests indicate that frost or ground ice collections can be removed sufficiently for flight by the thermal ice-prevention system. The flight-test removal of natural ice indicates that protection is realized almost immediately in flight upon placing the heating equipment in operation.

Unprotected Surfaces

The unprotected surfaces which accumulated ice in nearly all the natural-icing conditions encountered were the engine cowling, the carburetor air inlets, the heat-exchanger air scoops, the stabilizer splices, the stabilizer and wing-tip splices, the antennas, the antenna masts, the airspeed masts, the free-air thermometer, and the dome on top of the fuselage. After flight 60, inspection of the airplane revealed slight rime-ice accretions on the underside of the ailerons near the hinge region and on the underside inboard ends of the elevators. These ice accretions were evidently caused by air flow through the aileron gap and through the gap between the inboard ends of the elevators and the fuselage fairing. Ice formations on some of the unprotected surfaces are shown in figures 15 to 22. The heaviest ice formations were realized during flight 50 in heavy-icing conditions. Figures 19, 20, and 21 are photographs taken after landing of some of the ice accumulations resulting from this flight. These ice formations were much larger in flight. The temperature of the ambient air before landing in Minneapolis was 38° F and the ice was melting and falling off at the time the picture was taken. During flight, the ice on the cowling (fig. 19) had extended 2 to 3 feet rearward along the nacelle sides and the ice on the nose of the airplane (fig. 20) had extended rearward over the windshields.

The ice formations on the carburetor air inlets and the heat-exchanger air scoops were never sufficient to greatly restrict air flow. If the airplane were operated for a sufficient length of time in a heavy-icing condition, however, the ice accumulations on the carburetor air inlets could probably cause engine failure, and those on the exchanger scoops could probably cause failure of the thermal ice-prevention equipment. The pilot's free-air thermometer and the standard airspeed installations were frequently rendered useless due to ice formation. The ice on the antennas at times caused them to fail and rendered the radio equipment useless.

Heat Exchangers

The heat exchangers employed, completely described in reference 2, were removed from the airplane, sandblasted, and inspected after 100 hours and 173 hours of total flight testing. The 100-hour inspection indicated some deformation of the heat-exchanger plates and cracks as pictured in figures 23 and 24. The cracks were welded and the heat exchangers were reinstalled in the nacelles of the C-46 airplane for further flight testing. After 73 additional hours of testing, marked deformation of the heat-exchanger plates was evident, as well as more cracking as shown in figures 25 and 26. This deformation of the heat-exchanger plates probably changed the characteristics of the heat exchangers during the flight-testing period.

General

The handling and performance of the C-46 airplane in natural-icing conditions were only slightly affected during all the flights except flight 49. Upon encountering the severe inclement weather conditions of flight 49, during which snow and ice formed on the leading edges of the wings, the indicated airspeed of the airplane dropped from 140 to 120 miles per hour while operating at the same flight conditions. Viewed through a stroboscope, the propellers had accumulated continuous ice formations from the tips of the propeller anti-icing feed shoes to the ends of the propeller blades on the leading edges and thrust faces of the blades. The ice on the propellers and on the unprotected surfaces was evidently responsible for the decrease in airspeed. During the other flights in moderate- and heavy-icing conditions, the indicated airspeeds were noted to drop off very slightly with time as ice accumulated on the unprotected surfaces of the airplane and on the propellers.

CONCLUSIONS

1. The thermal ice-prevention system as applied to the C-46 airplane permitted operation in all natural-icing conditions encountered without the loss of functional efficiency of the heated surfaces.

2. A comparison of the experimental flight data with the design analysis indicates that the analytical method employed, while providing a conservative basis for the design of a thermal ice-prevention system, is not precise and requires further refinement.

3. Ice may be prevented from forming on a windshield by the passage of heated air over the outer surface of the windshield; however, additional data are required to establish design criteria for such an installation.

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2. Jackson, Richard: An Investigation of a Thermal Ice-Prevention System for a C-46 Cargo Airplane. II - The Design, Construction, and Preliminary Tests of the Exhaust-Air Heat Exchanger. NACA ARR No. 5A03a, 1945.

3. Jones, Alun R., and Spies, Ray J., Jr.: An Investigation of a Thermal Ice-Prevention System for a C-46 Cargo Airplane. III - Description of Thermal Ice-Prevention Equipment for Wings, Empennage, and Windshield. NACA ARR No. 5A03b, 1945.

4. Rodert, Lewis A., Clousing, Lawrence A., and McAvoy, William H.: Recent Flight Research on Ice Prevention. NACA ARR, Jan. 1942.

5. Jones, Alun R., and Rodert, Lewis A.: Development of Thermal Ice-Prevention Equipment for the B-24D Airplane. NACA ACR, February 1943. (Classification changed to "Restricted," Sept. 1943.)

6. Lock, Bonne C.: Flight Tests of the Thermal Ice-Prevention Equipment on the B-17F Airplane. NACA ARR No. 4B02, 1944.

7. Ditton Laboratory Staff: Hot Air De-Icing - Heat Transfer in the Double Skin. TN No. S.M.E. 208, R.A.E. (British/U. S. Restricted), Jan. 1944.

Pressure altitude (ft)	Standard carburetor air temperature (°C)	Operating condition	2050 rpm cruise	1900 rpm cruise	Maximum range cruise	Climb at 400 feet per minute	Descent at 400 feet per minute
		Percent hp	55	55	----	----	55
		hp	880	880	----	----	880
Sea level	15	M.P. in. Hg	31.9	32.7	28.7	30.7	32.6
		I.A.S. mph	189	189	147	130	211
		rpm	2050	1900	1500	2050	1900
2,000	11	M.P. in. Hg	30.4	32.1	----	30.0	32.0
		I.A.S. mph	187	187	----	130	208
		rpm	2050	1900	----	2050	1900
4,000	7	M.P. in. Hg	29.8	31.4	----	29.1	31.3
		I.A.S. mph	184	184	----	130	205
		rpm	2050	1900	----	2050	1900
5,000	5	M.P. in. Hg	----	----	26.8	----	----
		I.A.S. mph	----	----	147	----	----
		rpm	----	----	1600	----	----
6,000	3	M.P. in. Hg	29.1	30.8	----	28.4	30.7
		I.A.S. mph	182	182	----	130	203
		rpm	2050	1900	----	2050	1900
8,000	-1	M.P. in. Hg	28.5	30.2	----	27.7	30.0
		I.A.S. mph	179	179	----	130	200
		rpm	2050	1900	----	2050	1900
10,000	-5	M.P. in. Hg	27.8	29.5	25.6	27.0	29.4
		I.A.S. mph	176	176	147	130	198
		rpm	2050	1900	1700	2050	1900
12,000	-9	M.P. in. Hg	27.5	28.8	----	26.4	27.3
		I.A.S. mph	174	174	----	130	195
		rpm	2050	1900	----	2050	2050
14,000	-13	M.P. in. Hg	26.9	31.2	----	25.8	26.9
		I.A.S. mph	171	171	----	130	193
		rpm	2050	1900	----	2050	2050
15,000	-15	M.P. in. Hg	----	----	23.6	----	----
		I.A.S. mph	----	----	147	----	----
		rpm	----	----	1900	----	----
16,000	-17	M.P. in. Hg	29.3	30.7	----	25.3	28.4
		I.A.S. mph	168	168	----	130	190
		rpm	2050	1900	----	2050	2050
18,000	-21	M.P. in. Hg	28.8	----	----	24.4	----
		I.A.S. mph	165	----	----	130	----
		rpm	2050	----	----	2200	----

Note: 1. Gross weight of airplane, 40,000 pounds.
2. Reduce M.P. by ½ in. Hg for each 12°C below standard carburetor air temperature. Increase M.P. by ½ in. Hg for each 12°C above standard carburetor air temperature.
3. Below double line, use high blower.

TABLE I

C-46 AIRPLANE OPERATING CONDITIONS

FLIGHT Nº	RUN Nº	PRESSURE ALTITUDE, (FT)	CORRECTED INDICATED AIRSPEED (MPH)	AMBIENT AIR (°F)	(2) AIRPLANE OPERATING CONDITIONS
(1) 22	12	3,900	187	36	1900 R.P.M. CRUISE
(1) 22	13	4,000	187	36	2050 R.P.M. CRUISE
(1) 22	14	3,900	149	32	MAX. RANGE CRUISE
(1) 22	8	6,000	184	30	1900 R.P.M. CRUISE
60	1	10,430	154	10	1900 R.P.M. CRUISE
37	1	13,760	152	8	1900 R.P.M. CRUISE
61	3	18,000	138	-12	1900 R.P.M. CRUISE
61	5	18,000	153	-12	2050 R.P.M. CRUISE
61	6	17,950	130	-13	MAX. RANGE CRUISE

(1) NO HEAT FLOW TO WINS CENTER PANEL.
(2) SEE TABLE I.

PART I. - OPERATING CONDITIONS

TABLE II
PERFORMANCE OF C-46 THERMAL ICE-PREVENTION SYSTEM DURING LEVEL FLIGHT IN DRY AIR.

FLIGHT NO.	RUN NO.	EXCHANGER HEAT FLOWS (1000 BTU/HR.)			HEAT FLOWS TO HEATED SURFACES (1000 BTU/HR.)			
		① LEFT OUTBOARD	② LEFT INBOARD	③ RIGHT INBOARD.	LEFT WING OUTER PANEL	RIGHT STABILIZER	FIN	TO SECONDARY EXCHANGER
22	12	392	395	205	392	102	136	95
22	13	391	412	231	391	111	149	102
22	14	266	275	156	266	86	103	72
22	8	373	396	207	374	102	136	92
60	1	356	338	153	356	84	132	85
37	1	329	344	149	329	90	113	70
61	3	323	263	129	323	69	113	78
61	5	362	322	147	362	73	122	83
61	6	287	243	134	287	62	103	73

① - TEMPERATURE RISE USED TO CALCULATE HEAT TRANSFERRED = [(A_{62}) - (AMBIENT-AIR TEMPERATURE)] (°F).

② - TEMPERATURE RISE USED TO CALCULATE HEAT TRANSFERRED = [(A_{66}) - (AMBIENT-AIR TEMPERATURE)] (°F).

③ - PORTION OF RIGHT INBOARD HEAT-EXCHANGER HEAT FLOWS MEASURED AT VENTURI NO. 3.

PART 2.-HEAT DISTRIBUTION.

TABLE II (CONTINUED)

FLIGHT NO.	RUN NO.	AVERAGE HEAT DELIVERED PER SQUARE FT. OF DOUBLE SKIN LEADING EDGE SURFACE (BTU/HR)			AVERAGE HEAT FLOW THRU HEATED SKIN SURFACE PER SQUARE FT. OF DOUBLE-SKIN SURFACE (BTU/HR)			RATIO OF HEAT FLOW THRU HEATED SKIN SURFACE TO HEAT DELIVERED			AVERAGE TEMP. RISE OF WING OUTER PANEL 0% CHORD (°F)
		LEFT WING OUTER PAN.	RIGHT STABILIZ.	VERTICAL FIN	① LEFT WING OUTER PAN	② RIGHT STABILIZ.	③ VERTICAL FIN	LEFT WING OUTER PAN	RIGHT STABILIZ.	VERTICAL FIN	
22	12	3700	4750	7560	1470	2270	3660	0.40	0.48	0.48	120
22	13	3700	5170	8310	1470	2300	3970	.40	.44	.48	121
22	14	2520	4020	5750	880	1640	3900	.35	.41	.68	99
22	8	3540	4760	7570	1330	2150	3660	.38	.45	.48	129
60	1	3370	3940	7390	1230	1760	3840	.36	.45	.52	143
37	1	3120	4200	6280	1320	1490	3090	.42	.35	.49	125
61	3	3060	3220	6280	1130	1410	3260	.37	.44	.52	153
61	5	3430	3420	6800	1240	1520	3560	.36	.44	.52	155
61	6	2720	2900	5740	1020	1250	3940	.37	.43	.69	134

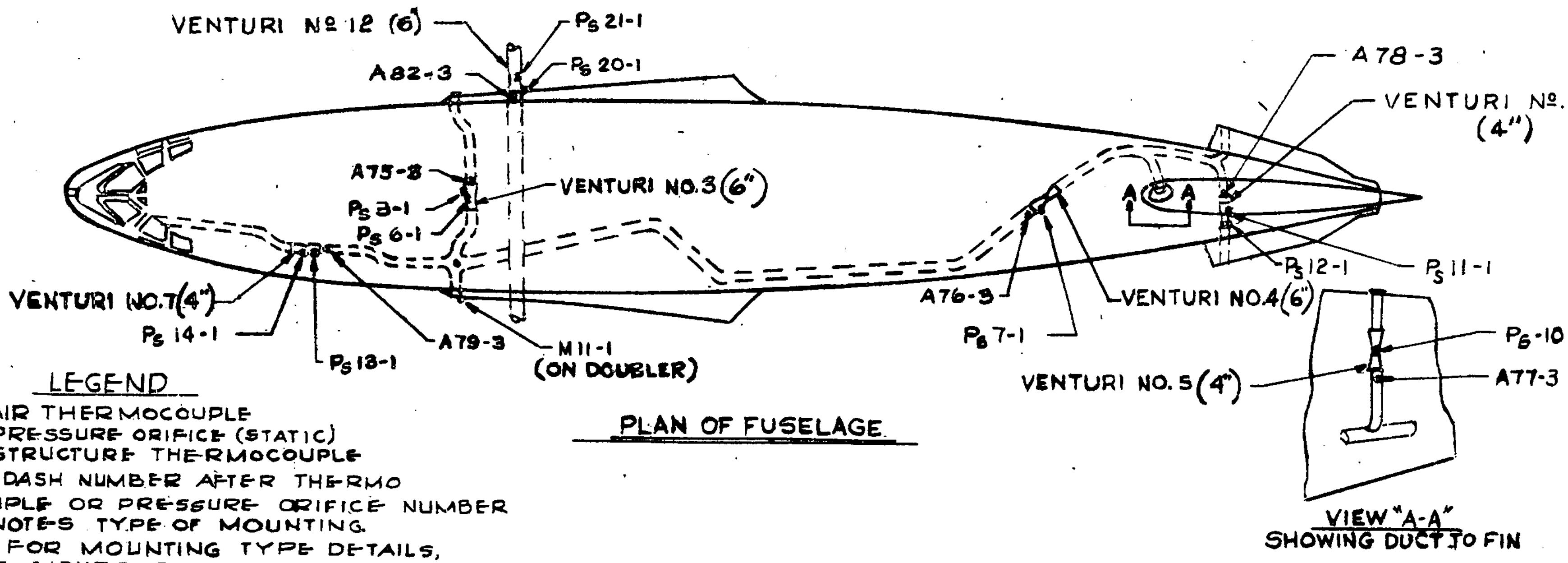
① CALCULATED ON BASIS OF AVERAGE TEMPERATURE DROP OF THE HEATED AIR IN THE CORRUGATIONS AT STATIONS 24,84,159,290 AND 380 AND THE TOTAL AIRFLOW RATE FROM LEFT OUTBOARD EXCHANGER.

② CALCULATED ON BASIS OF AVERAGE TEMPERATURE DROP OF THE HEATED AIR IN THE CORRUGATIONS AT STATIONS 69,125 AND 171, AND THE TOTAL AIRFLOW RATE TO THE RIGHT STABILIZER.

③ CALCULATED ON BASIS OF AVERAGE TEMPERATURE DROP OF THE HEATED AIR IN THE CORRUGATIONS AT STATIONS 124 AND 170 AND THE TOTAL AIR-FLOW RATE TO THE VERTICAL FIN.

PART 3.– SURFACE HEATING VALUES.

TABLE II (CONTINUED)



LEGEND

A - AIR THERMOCOUPLE
P_S - PRESSURE ORIFICE (STATIC)
M - STRUCTURE THERMOCOUPLE

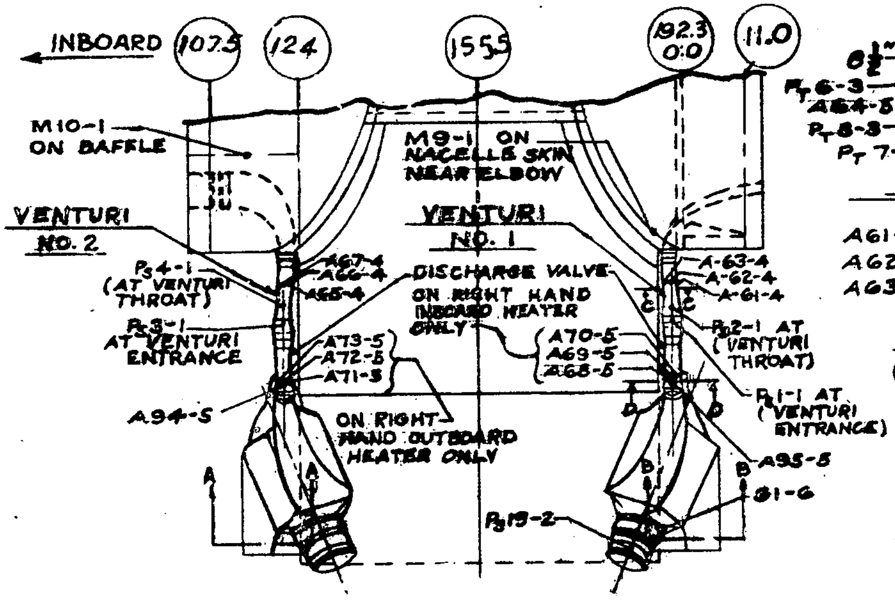
DASH NUMBER AFTER THERMOCOUPLE OR PRESSURE ORIFICE NUMBER DENOTES TYPE OF MOUNTING.

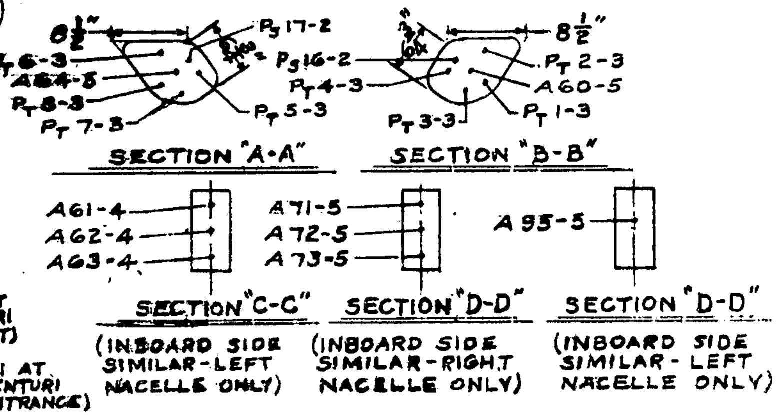
FOR MOUNTING TYPE DETAILS, SEE FIGURE 3.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	VENTURI FLOW RATES (LB/HR) NO.3	NO.4	NO.5	NO.6	NO.7	NO.12	TEMPERATURE (°F) A75	A76	A77	A78	A79	A82	M11
22	12	36	2,080	4,130	1,760	1,320	1,230	0	437	368	353	353	353	178	125
22	13	36	2,055	3,995	1,715	1,275	1,185	0	491	403	393	393	388	178	125
22	14	32	1,765	3,360	1,440	1,200	1,050	0	393	337	327	327	314	170	125
22	8	30	1,860	3,810	1,600	1,210	1,100	0	481	388	378	378	373	174	125
60	1	10	1,200	2,685	1,280	805	875	0	525	446	432	436	405	161	93
37	1	8	1,320	2,630	1,245	770	850	0	466	401	378	381	388	152	126
61	3	-12	960	2,220	1,060	650	770	0	530	440	419	420	402	180	120
61	5	-12	910	2,280	1,080	665	785	0	631	464	445	446	418	187	116
61	6	-13	1,240	2,140	1,020	610	700	0	428	418	400	402	409	183	112

PART 4.-FUSELAGE AIR TEMPERATURES, AIR-FLOW RATES, & DOUBLER TEMPERATURES.

TABLE II (CONTINUED)





LEGEND

A - AIR THERMOCOUPLE
M - STRUCTURE THERMOCOUPLE
P_S - PRESSURE ORIFICES (STATIC)
P_T - PRESSURE ORIFICES (TOTAL)

DASH NUMBER AFTER THERMOCOUPLE OR PRESSURE ORIFICE NUMBER DENOTES TYPE OF MOUNTING.

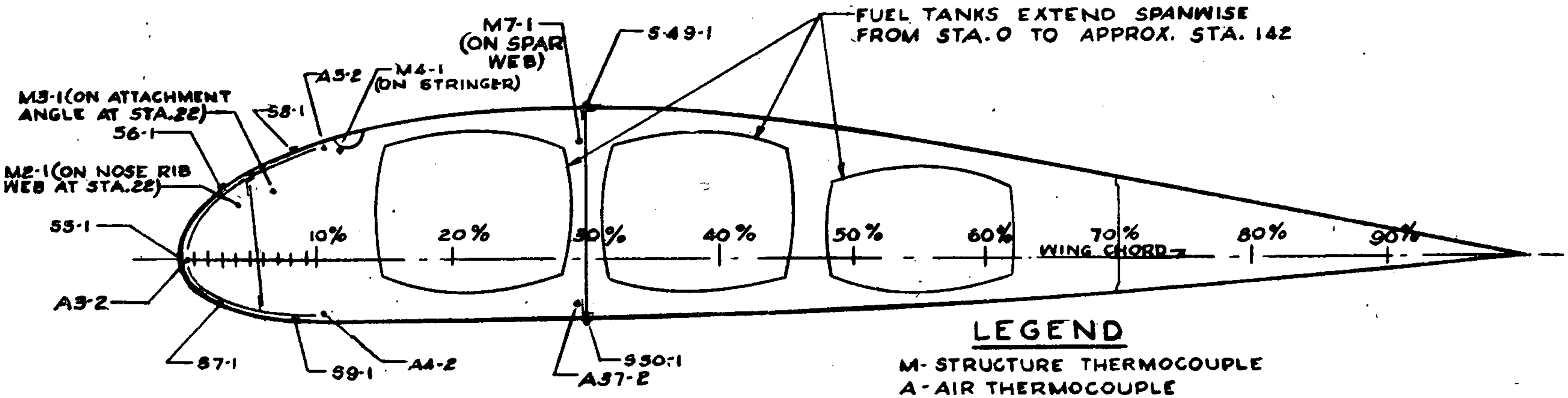
FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

THERMOCOUPLES NOS. A-68 TO A-73 INCL ON RIGHT HAND NACELLE ONLY.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	VENTURI FLOW RATES (LB/HR) ① NO 1	② NO. 2	TEMPERATURE (°F) A61	A62	A63	A95	A65	A66	A67	A94	M10	M9	A68	A69	A70	A71	A72	A73
22	12	36	6,710	5,130	273	278	243	270	337	353	337	328	160	76	511	---	462	288	278	---
22	13	36	6,640	4,950	278	280	250	274	358	378	360	343	165	85	540	---	516	297	288	---
22	14	32	5,300	4,030	240	240	205	245	309	314	274	284	153	85	447	---	368	260	230	---
22	8	30	6,200	4,750	279	279	250	265	348	373	348	343	163	82	535	---	501	289	284	---
60	1	10	5,020	3,415	312	302	260	313	---	414	384	440	260	80	562	560	646	237	290	306
37	1	8	4,810	3,575	303	290	---	288	396	401	376	353	236	71	521	---	467	274	270	---
61	3	-12	3,780	2,520	354	339	290	358	---	413	369	420	247	58	538	550	628	251	320	338
61	5	-12	4,015	2,870	372	357	310	368	---	442	400	440	266	63	621	621	696	287	348	361
61	6	-13	3,460	2,220	343	328	272	337	---	431	380	431	252	64	440	447	564	248	308	350

① - FLOW RATE CALCULATION BASED ON TEMPERATURE A62 AT VENTURI NO. 1
② - FLOW RATE CALCULATION BASED ON TEMPERATURE A66 AT VENTURI NO. 2

PART 5.- HEAT-EXCHANGER AIR TEMPERATURES & FLOW RATES.
TABLE II (CONTINUED)



STATION 24

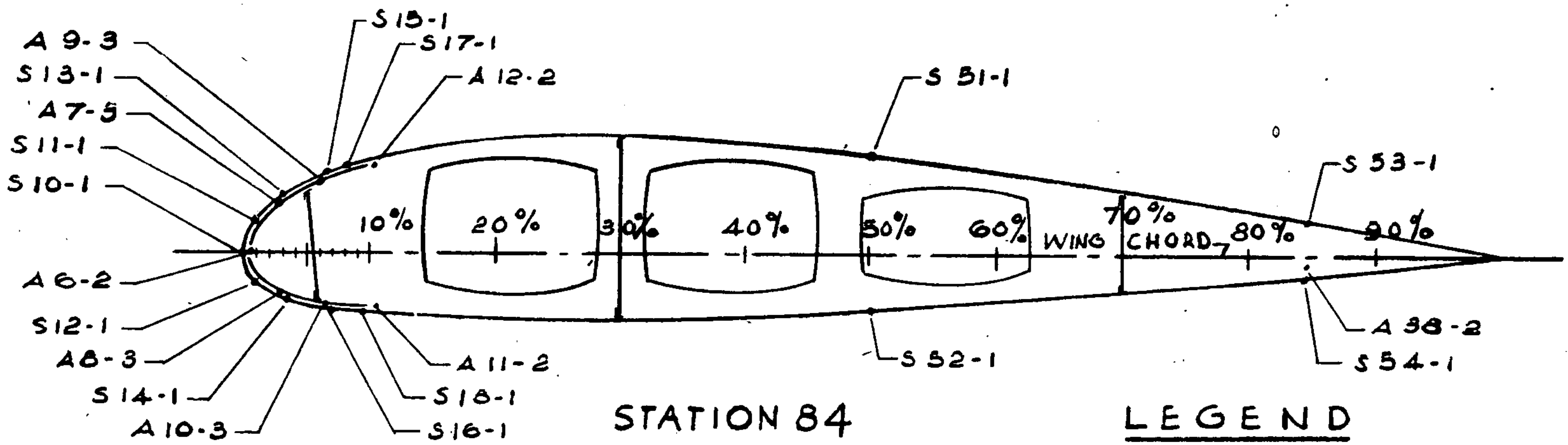
LEGEND

M- STRUCTURE THERMOCOUPLE
A- AIR THERMOCOUPLE
S- SKIN THERMOCOUPLE.
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.
FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)														
			S49	S8	S6	S5	S7	S9	S50	A5	A3	A4	A37	M2	M3	M4	M7
22	12	36	55	80	105	155	110	90	45	101	213	96	52	200	150	95	62
22	13	36	55	75	105	155	110	85	45	111	220	106	55	200	165	95	65
22	14	32	50	67	90	140	110	75	45	85	175	87	50	165	145	76	65
22	8	30	45	76	101	160	106	86	46	106	215	101	46	202	160	86	57
60	1	10	37	88	128	164	140	95	28	110	233	107	37	220	175	83	52
37	1	8	32	70	116	146	126	78	27	93	224	86	32	201	161	71	40
61	3	-12	16	78	120	160	136	88	3	98	245	93	15	229	182	69	35
61	5	-12	26	95	146	184	146	99	11	116	266	104	21	256	197	83	42
61	6	-13	16	79	130	161	133	85	3	98	234	41	11	226	177	68	36

PART 6.-WING OUTER PANEL (STATION 24) SKIN, STRUCTURE, AND AIR TEMPERATURES.

TABLE II. (CONTINUED)



STATION 84

LEGEND

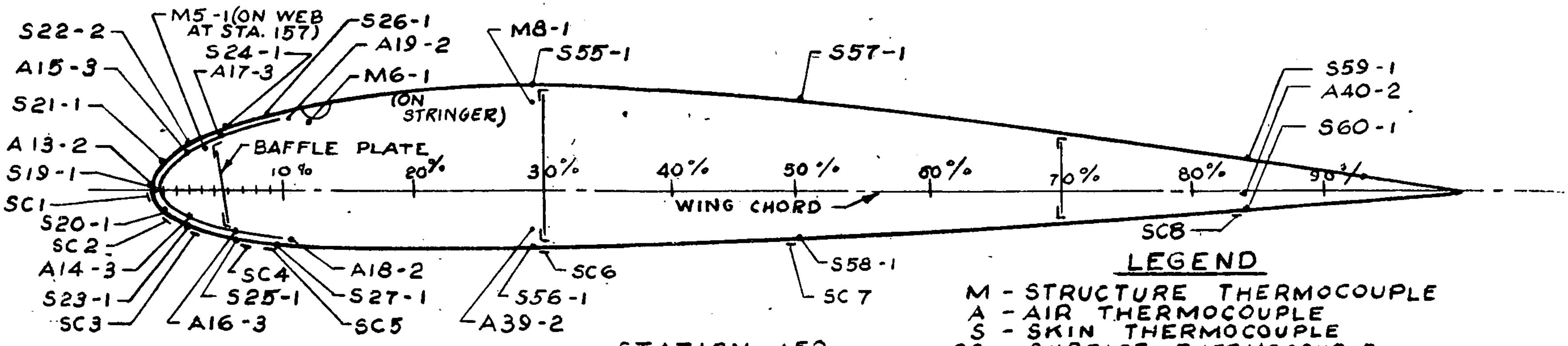
A- AIR THERMOCOUPLE

S- SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE DENOTES TYPE OF MOUNTING.
FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)																				
			S53	S51	S17	S15	S13	S11	S10	S12	S14	S16	S18	S52	S54	A12	A9	A7	A6	A8	A10	A11	A38
22	12	36	37	41	90	110	145	150	190	150	170	100	95	41	37	120	150	174	215	175	160	115	40
22	13	36	35	40	90	110	150	155	200	160	170	106	95	40	35	125	150	175	225	175	165	121	35
22	14	32	35	35	72	91	125	125	165	130	145	111	96	35	35	101	130	148	185	150	135	106	35
22	8	30	31	31	91	101	145	140	195	151	165	101	91	36	31	121	140	195	225	175	160	116	32
60	1	10	21	25	69	93	143	145	155	154	171	119	91	25	21	100	125	168	231	180	161	110	23
37	1	8	20	22	63	86	140	141	136	141	158	91	71	22	20	86	106	151	224	161	130	91	18
61	3	-12	2	0	50	81	140	138	147	145	171	126	90	3	-7	79	111	164	245	172	158	109	4
61	5	-12	0	4	67	105	166	165	175	161	186	135	92	4	-2	97	139	192	265	192	177	116	1
61	6	-13	3	1	53	83	146	146	152	140	162	120	88	1	-5	74	114	167	237	167	156	101	-1

PART 7.- WING OUTER PANEL (STATION 84) SKIN AND AIR TEMPERATURES.
TABLE II-(CONTINUED)



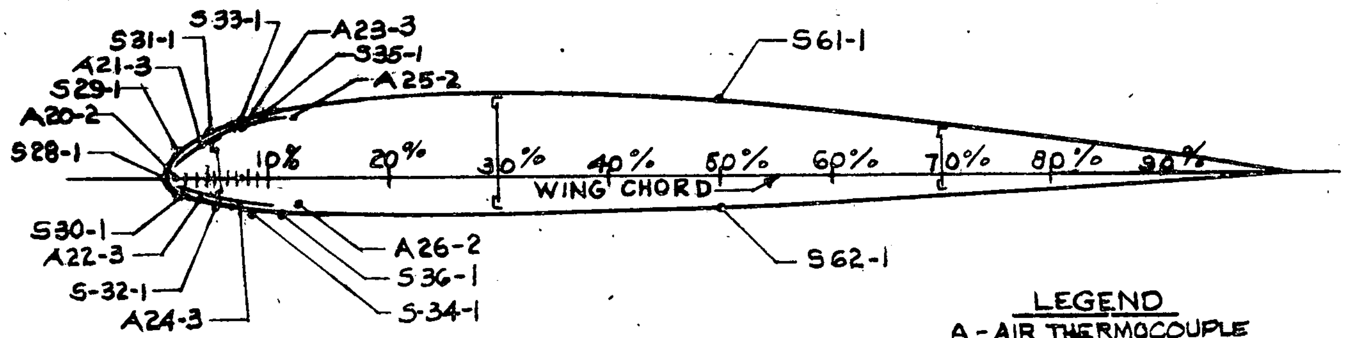
STATION 159

LEGEND

M - STRUCTURE THERMOCOUPLE
A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE
SC - SURFACE THERMOCOUPLE
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.
FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)																										
			S59	S57	S55	S26	S24	S22	S21	S19	S20	S23	S25	S27	S56	S58	S60	A19	A17	A15	A13	A14	A16	A18	A40	A39	M6	M5	M8
22	12	36	37	41	50	85	100	145	145	142	152	135	101	85	45	41	37	120	155	170	210	165	160	110	41	57	95	180	68
22	13	36	35	40	45	85	105	150	150	140	155	145	110	85	45	40	35	121	150	175	220	165	180	116	36	64	95	150	70
22	14	32	35	35	41	67	80	124	125	116	142	130	120	101	41	35	35	95	120	145	180	145	135	115	35	52	80	115	60
22	8	30	31	31	46	81	96	145	140	145	145	150	106	86	41	31	26	116	150	173	210	165	163	116	32	57	91	160	67
60	1	10	18	25	32	105	132	156	150	148	156	161	148	130	28	25	18	126	161	185	230	169	166	130	20	52	93	205	55
37	1	8	20	22	32	56	66	111	121	117	121	116	76	58	22	22	20	83	113	-	210	136	131	81	16	37	68	-	47
61	3	-12	-1	0	11	90	117	150	140	138	146	153	114	114	4	-2	-8	120	152	178	238	158	158	114	-3	25	77	205	35
61	5	-12	-2	1	18	130	151	176	166	160	164	160	155	129	11	2	-2	143	175	206	258	176	176	130	-3	36	97	229	42
61	6	-13	-7	0	11	80	119	154	145	140	144	147	132	105	5	1	-5	104	151	180	230	155	153	104	-8	24	69	294	35

PART 8.- WING OUTER PANEL (STATION 159) SKIN, STRUCTURE, & AIR TEMPERATURES. TABLE II - (CONTINUED)

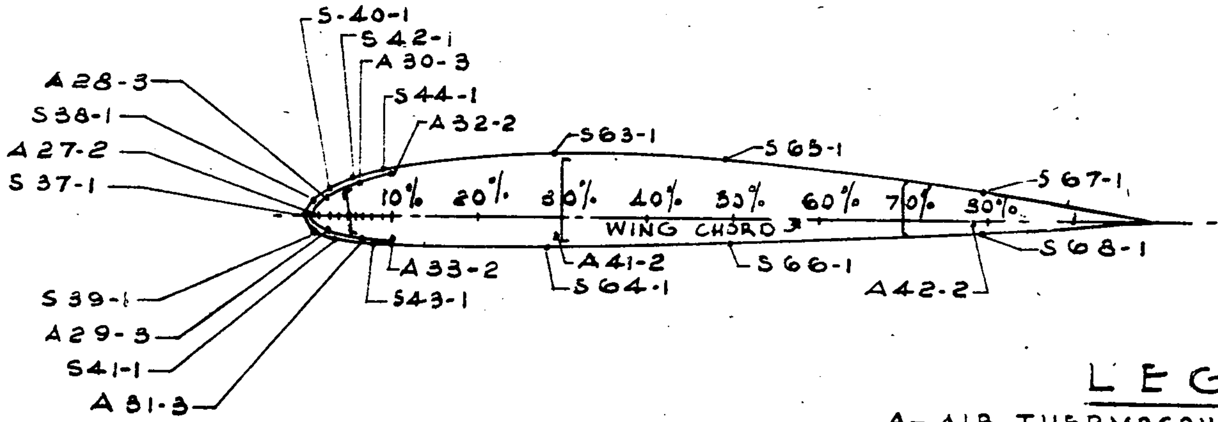


STATION 290

LEGEND
A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.
FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	TEMPERATURE (°F)																	
			S61	S35	S33	S31	S29	S28	S30	S32	S34	S36	S62	A25	A23	A21	A20	A22	A24	A26
22	12	36	41	137	150	170	160	150	170	170	150	115	41	145	175	175	220	180	172	140
22	13	36	40	140	155	170	160	150	160	165	150	125	40	150	180	178	255	190	170	145
22	14	32	35	110	121	140	135	121	135	140	125	116	35	120	145	145	185	155	135	130
22	8	30	31	135	150	165	152	150	150	165	150	125	31	147	175	180	220	185	170	147
60	1	10	25	135	153	166	158	152	161	171	152	133	25	140	185	185	236	190	170	148
37	1	8	22	96	125	156	141	131	141	161	130	105	22	96	151	161	223	171	141	116
61	3	-12	1	119	149	162	151	142	151	166	148	130	-2	120	175	175	250	184	162	145
61	5	-12	5	145	170	183	172	161	166	182	161	144	1	141	197	200	268	200	176	156
61	6	-13	2	112	152	164	154	142	145	160	140	124	0	110	173	176	240	176	156	139

PART 9.-WING OUTER PANEL (STATION 290) SKIN AND AIR TEMPERATURES.
TABLE II - (CONTINUED.)



STATION 380

LEGEND

A- AIR THERMOCOUPLE

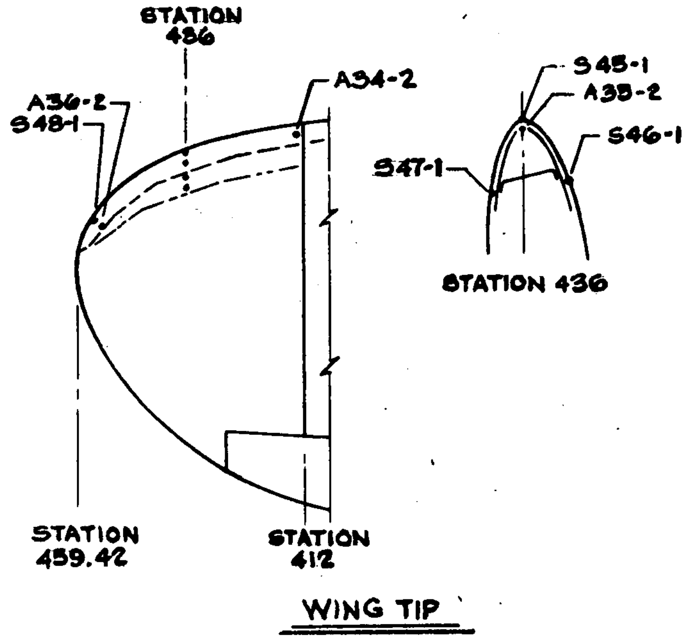
S- SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)																						
			S67	S65	S63	S44	S42	S40	S38	S37	S39	S41	S43	S64	S66	S68	A32	A30	A28	A27	A29	A31	A33	A41	A42
22	12	36	37	41	54	100	125	165	178	142	170	150	100	54	41	37	130	170	185	233	188	150	145	30	41
22	13	36	35	40	50	100	125	165	178	140	170	135	100	50	40	35	135	175	190	235	190	150	150	30	36
22	14	32	35	35	45	90	95	140	155	116	145	135	125	45	35	35	120	145	165	190	165	135	140	67	35
22	8	30	31	41	46	96	116	165	175	145	160	155	106	46	31	31	134	174	190	230	190	167	153	72	32
60	1	10	18	25	37	130	144	171	180	145	177	167	130	38	25	18	140	183	202	245	200	166	161	70	20
37	1	8	20	22	32	101	126	161	169	130	166	153	115	32	22	20	116	156	184	233	184	141	136	56	16
61	3	-12	0	3	13	118	138	168	176	138	175	169	145	13	0	-6	132	176	198	264	193	165	163	47	-4
61	5	-12	1	5	21	137	157	188	197	156	190	184	149	21	5	0	146	199	218	283	218	182	176	58	0
61	6	-13	-2	2	16	122	142	168	177	139	166	160	140	16	2	-4	133	176	196	255	192	160	169	45	-8

PART 10.-WING OUTER PANEL (STATION 380) SKIN AND AIR TEMPERATURES.
TABLE II (CONTINUED)

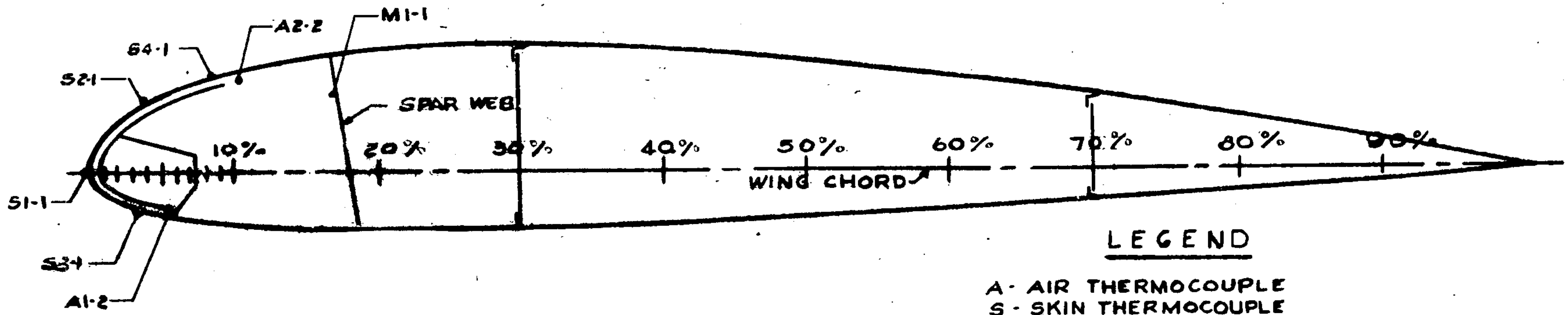


LEGEND

A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING FOR MOUNTING DETAILS SEE FIGURE 3.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	TEMPERATURE (°F) A34	S48	A36	S46	S45	S47	A35
22	12	36	205	76	200	135	98	135	205
22	13	36	210	75	195	158	93	150	205
22	14	32	175	76	160	155	76	150	165
22	8	30	210	72	190	145	95	140	205
60	1	10	221	74	198	167	85	163	215
37	1	8	206	71	183	136	75	132	196
61	3	-12	232	16	205	157	68	150	224
61	5	-12	252	71	224	163	80	162	240
61	6	-13	226	62	196	164	67	156	213

PART II.-WING TIP SKIN & AIR TEMPERATURES.
TABLE II (CONTINUED)



STATION 90

LEGEND

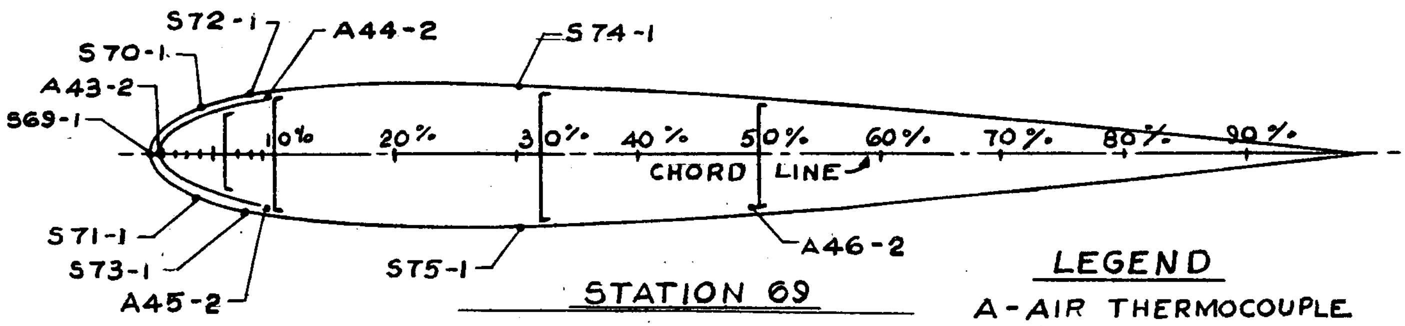
A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE
M - STRUCTURE THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)						
			S4	S2	S1	S3	A2	A1	M1
22	12	36	43	43	65	55	55	125	57
22	13	36	35	40	65	55	45	125	60
22	14	32	35	36	57	52	41	101	57
22	8	30	31	31	62	46	43	116	52
60	1	10	53	75	189	173	42	242	53
37	1	8	37	51	170	150	47	111	51
61	3	-12	32	58	176	159	32	222	32
61	5	-12	49	80	193	171	48	239	32
61	6	-13	37	72	182	160	33	220	28

PART 12.-WING CENTER PANEL (STATION 90) SKIN AND AIR TEMPERATURES.
TABLE II (CONTINUED)



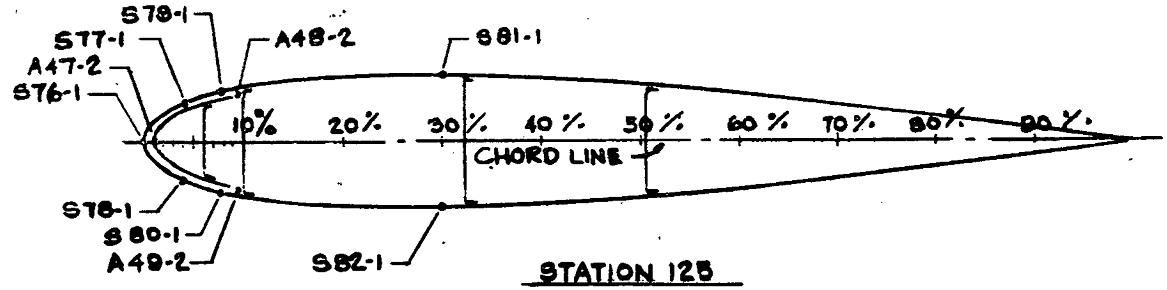
STATION 69

LEGEND

A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.
FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT No.	RUN No.	AMBIENT AIR (°F)	TEMPERATURE (°F)										
			S74	S72	S70	S69	S71	S73	S75	A44	A43	A45	A46
22	12	36	45	130	208	178	198	90	45	135	330	135	35
22	13	36	40	130	208	188	188	85	41	140	347	140	41
22	14	32	35	135	175	150	170	100	35	128	288	125	30
22	8	30	31	130	210	175	190	86	31	140	343	132	31
60	1	10	16	125	195	163	176	92	19	102	351	93	18
37	1	8	20	101	172	141	158	76	20	76	311	76	17
61	3	-12	1	114	177	144	161		-4	88	340	82	-7
61	5	-12	3	135	202	159	171	85	1	99	356	78	-3
61	6	-13	-1	112	177	144	157	92	-4	88	330	87	-8

PART 13.- STABILIZER (STATION 69) SKIN & AIR TEMPERATURES.
TABLE II - (CONTINUED)



STATION 125

LEGEND

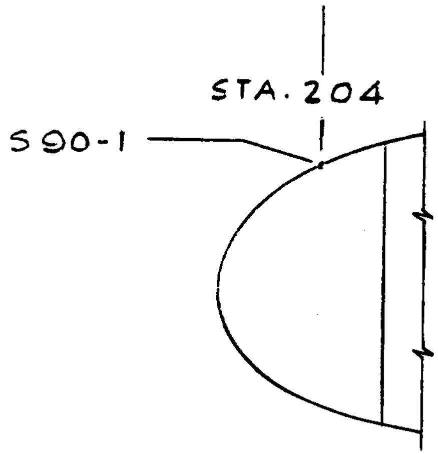
A- AIR THERMOCOUPLE
S- SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

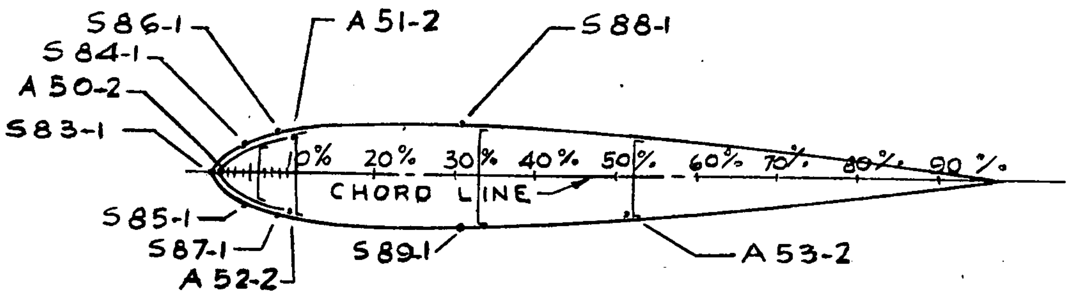
FOR MOUNTING DETAILS SEE FIGURE 3.

FLIGHT NO.	RUN NO.	AMBIENT AIR(°F)	TEMPERATURE(°F)									
			S81	S79	S77	S76	S78	S80	S82	A48	A47	A49
22	12	36	43	120	170	140	178	90	50	140	288	155
22	13	36	41	117	173	145	183	101	45	140	302	155
22	14	32	42	111	145	120	165	125	36	125	253	150
22	8	30	41	116	165	135	180	86	36	140	294	155
60	1	10	28	108	158	134	190	120	25	125	326	171
37	1	8	22	96	146	116	166	101	20	106	276	136
61	3	-12	5	92	144	112	167	109	1	102	305	145
61	5	-12	10	109	163	129	188	118	5	116	328	155
61	6	-13	3	98	143	113	161	109	0	101	292	140

PART 14.-STABILIZER (STATION 125) SKIN & AIR TEMPERATURES
TABLE II (CONTINUED)



TIP



STATION 171

LEGEND

A—AIR THERMOCOUPLE
S—SKIN THERMOCOUPLE
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.
FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	TEMPERATURE (°F)											
			S90	S88	S86	S84	S83	S85	S87	S89	A51	A50	A52	A53
22	12	36	140	43	120	170	155	150	95	43	165	278	150	55
22	13	36	130	41	120	165	160	150	95	41	174	283	155	60
22	14	32	111	42	110	145	135	140	95	42	155	243	140	50
22	8	30	125	41	116	166	156	146	91	41	171	282	152	48
60	1	10	114	28	110	157	145	153	87	28	163	293	145	37
37	1	8	101	22	96	141	131	136	81	22	139	256	126	32
61	3	-12	90	5	93	136	121	135	82	2	139	270	125	15
61	5	-12	104	10	109	156	140	150	87	6	155	290	133	16
61	6	-13	91	5	99	138	125	132	90	1	140	263	128	11

PART 15.—STABILIZER (TIP AND STATION 171) SKIN AND AIR TEMPERATURES.
TABLE II (CONTINUED)

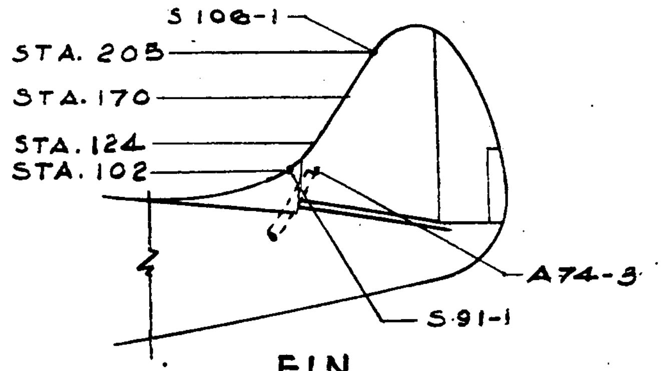
LEGEND

A - AIR THERMOCOUPLE

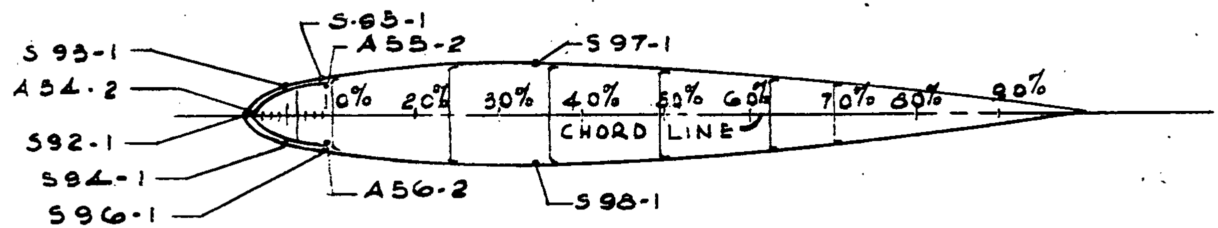
S - SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING

FOR MOUNTING TYPE DETAILS SEE FIGURE 3:-



FIN

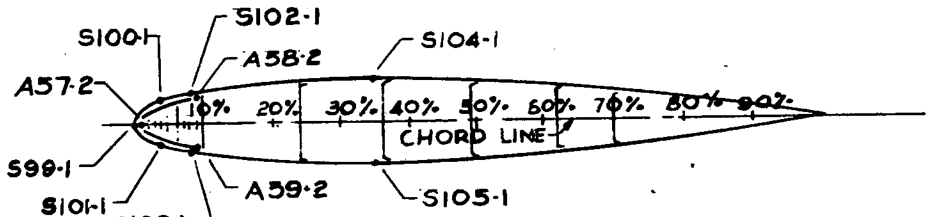


STATION 124

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)												
			S91	S106	A74	S97	S95	S93	S92	S94	S96	S98	A55	A54	A56
22	12	36	41	158	360	41	115	170	193	154	115	50	165	332	155
22	13	36	30	165	378	40	110	175	193	164	105	40	165	350	160
22	14	32	35	140	317	38	105	155	174	140	100	36	150	247	135
22	8	30	31	158	363	46	111	174	190	157	101	31	170	343	150
60	1	10	16	167	410	24	100	177	208	166	100	32	162	385	130
37	1	8	17	143	368	22	91	158	183	141	86	22	146	336	121
61	3	-12	-9	145	400	-3	75	161	187	144	71	-3	138	367	99
61	5	-12	1	161	420	1	85	173	207	156	80	-1	131	393	108
61	6	-13	-5	147	383	-4	78	162	192	145	73	-9	138	357	98

PART 16.-FIN (DORSAL, TIP, AND STATION 124) SKIN AND AIR TEMPERATURES.

TABLE II (CONTINUED)



STATION 170

LEGEND

A- AIR THERMOCOUPLE.
S- SKIN THERMOCOUPLE.

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS, SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)									
			S104	S102	S100	S99	S101	S103	S105	A58	A57	A59
22	12	36	41	120	174	131	155	120	52	185	307	155
22	13	36	40	115	183	26	161	115	45	188	327	155
22	14	32	41	110	165	120	155	105	41	165	273	135
22	8	30	41	122	177	122	157	115	41	180	320	148
60	1	10	27	105	180	173	171	32	37	163	352	128
37	1	8	32	100	164	151	151	96	27	161	303	113
61	3	-12	3	84	181	154	187	30	3	144	332	111
61	5	-12	5	90	181	171	175	32	4	153	354	108
61	6	-13	2	87	183	159	188	31	0	144	321	118

PART 17.- FIN (STATION 170) SKIN AND AIR TEMPERATURES.

TABLE II (CONCLUDED)

FLIGHT Nº	RUN Nº	PRESSURE ALTITUDE, (FT.)	CORRECTED INDICATED AIRSPEED (MPH)	AMBIENT AIR (°F)	(2) AIRPLANE OPERATING CONDITIONS
(1) 22	16	4,000	169	32	CLIMB
(1) 22	17	6,150	159	30	CLIMB
(1) 22	18	10,000	163	23	CLIMB
61	1	18,000	133	-12	CLIMB
61	2	18,000	179	-11	DESCENT
37	3	14,000	192	8	DESCENT
22	19	10,000	199	23	DESCENT
22	20	5,950	203	36	DESCENT
22	21	3,960	198	37	DESCENT

(1) NO HEAT FLOW TO WING CENTER PANELS.
(2) SEE TABLE I.

PART I.- OPERATING CONDITIONS

TABLE III

PERFORMANCE OF C-46 THERMAL ICE-PREVENTION SYSTEM DURING CLIMB & DESCENT TESTS IN DRY AIR.

FLIGHT NO.	RUN NO.	EXCHANGER HEAT FLOWS (1000 BTU/HR)			HEAT FLOWS TO HEATED SURFACES (1000 BTU/HR)			
		(1) LEFT OUTBOARD	(2) LEFT INBOARD	(3) RIGHT INBOARD	LEFT WING OUTER PANEL	RIGHT STABILIZER	FIN.	TO SECONDARY EXCHANGER
22	16	388	411	223	388	107	142	100
22	17	347	364	217	347	103	137	94
22	18	350	356	211	350	118	131	98
61	1	407	332	193	407	88	145	99
61	2	402	364	178	402	86	140	88
37	3	370	352	181	370	79	128	83
22	19	352	356	209	352	102	110	91
22	20	360	343	240	360	101	138	93
22	21	362	363	218	362	100	134	90

(1) - TEMPERATURE RISE USED TO CALCULATE HEAT TRANSFERRED = [(A_{62})(AMBIENT-AIR TEMPERATURE)] (°F.)

(2) - TEMPERATURE RISE USED TO CALCULATE HEAT TRANSFERRED: [(A_{66})(AMBIENT-AIR TEMPERATURE)] (°F.)

(3) - PORTION OF RIGHT INBOARD HEAT-EXCHANGER HEAT FLOWS MEASURED AT VENTURI NO. 3.

PART 2.-HEAT DISTRIBUTION.

TABLE III (CONTINUED)

FLIGHT NO.	RUN NO.	AVERAGE HEAT DELIVERED PER SQUARE FT. OF DOUBLE-SKIN LEADING EDGE SURFACE (BTU/HR)			AVERAGE HEAT FLOW THRU HEATED SKIN SURFACE PER SQUARE FT. OF DOUBLE-SKIN SURFACE (BTU/HR)			RATIO OF HEAT FLOW THRU HEATED SKIN SURFACE TO HEAT DELIVERED			AVERAGE TEMP. RISE OF WING OUTER PANEL 0% CHORD (°F)
		LEFT WING OUTER PAN.	RIGHT STABILIZ.	VERTICAL FIN	(1) LEFT WING OUTER PAN	(2) RIGHT STABILIZ.	(3) VERTICAL FIN	LEFT WING OUTER PAN.	RIGHT STABILIZ.	VERTICAL FIN	
22	16	3,680	4,990	7,940	1,390	2,220	2,670	0.38	0.44	0.34	137
22	17	3,290	4,820	7,650	1,300	2,100	2,660	.40	.44	.35	142
22	18	3,310	5,500	7,320	1,330	2,500	2,670	.40	.45	.37	148
61	1	3,860	4,080	8,060	1,410	1,720	2,720	.37	.42	.34	150
61	2	3,810	3,990	7,820	1,110	1,570	2,760	.29	.39	.35	146
37	3	3,500	3,680	7,160	1,490	1,630	2,260	.43	.44	.32	125
22	19	3,340	4,750	6,120	1,330	2,120	2,460	.40	.45	.40	120
22	20	3,420	4,730	7,670	1,410	2,160	2,490	.41	.46	.31	106
22	21	3,430	4,670	7,490	1,360	2040	2,350	.40	.43	.31	106

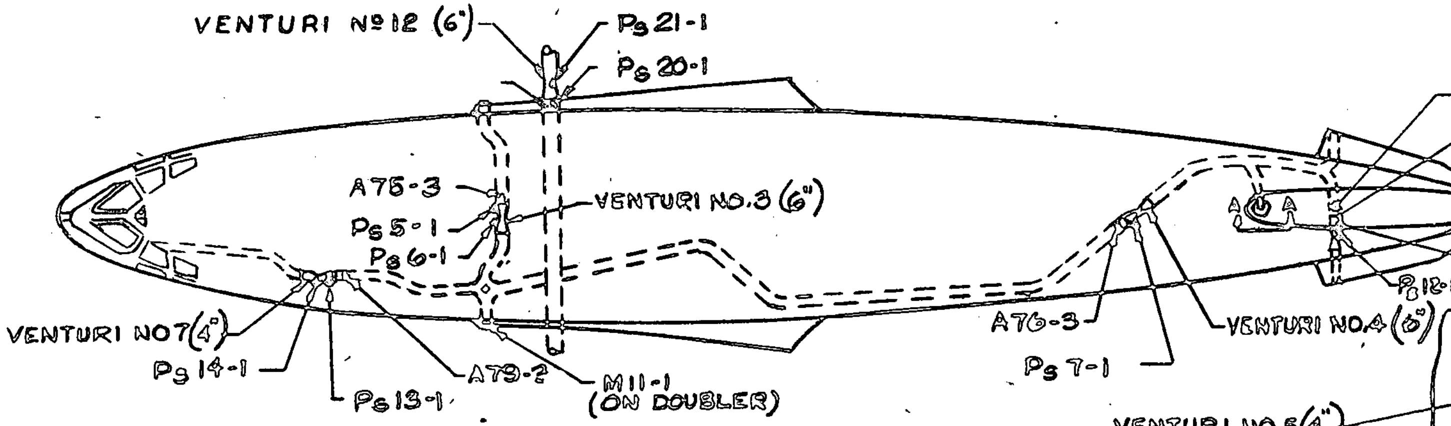
(1) CALCULATED ON BASIS OF AVERAGE TEMPERATURE DROP OF THE HEATED AIR IN THE CORRUGATIONS AT STATIONS 24, 84, 159, 290 AND 380 AND THE TOTAL AIR-FLOW RATE FROM LEFT OUTBOARD EXCHANGER.

(2) CALCULATED ON BASIS OF AVERAGE TEMPERATURE DROP OF THE HEATED AIR IN THE CORRUGATIONS AT STATIONS 69, 125 AND 171, AND THE TOTAL AIR-FLOW RATE TO THE RIGHT STABILIZER.

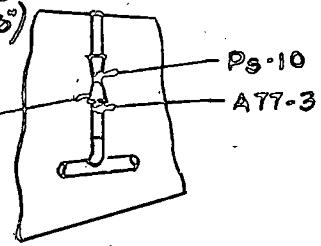
(3) CALCULATED ON BASIS OF AVERAGE TEMPERATURE DROP OF THE HEATED AIR IN THE CORRUGATIONS AT STATIONS 124 AND 170 AND THE TOTAL AIR-FLOW RATE TO THE VERTICAL FIN.

PART 3.- SURFACE HEATING VALUES.

TABLE III (CONTINUED)



PLAN OF FUSELAGE



VIEW "A-A"
SHOWING DUCT TO FIN

LEGEND

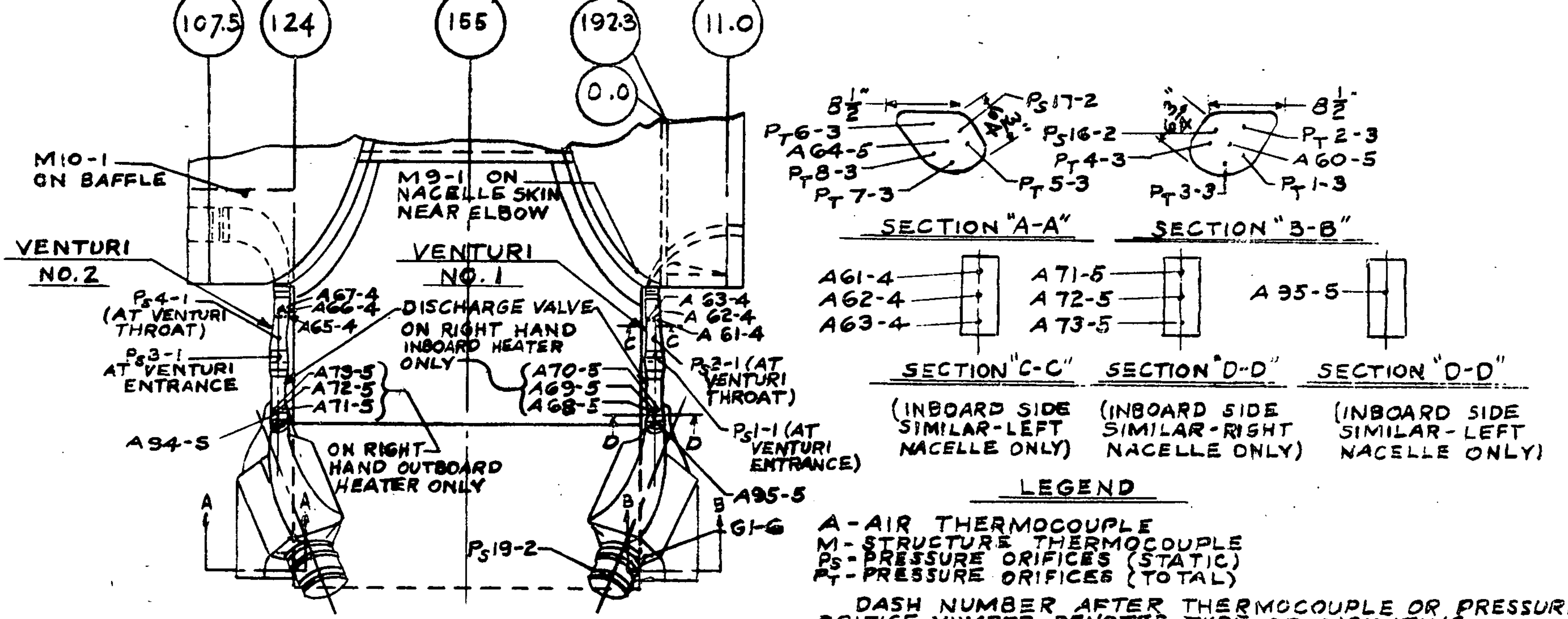
A - AIR THERMOCOUPLE
P_S - PRESSURE ORIFICE (STATIC)
M - STRUCTURE THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE OR PRESSURE ORIFICE NUMBER DENOTES TYPE OF MOUNTING.
FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	VENTURI FLOW RATES (LB/HR)						TEMPERATURE (°F)						
			NO.3	NO.4	NO.5	NO.6	NO.7	NO.12	A75	A76	A77	A78	A79	A82	M11
22	16	32	1,800	3,660	1,550	1,165	1,090	0	530	432	408	408	408	175	132
22	17	30	1,725	3,205	1,370	1,340	980	0	535	457	437	437	422	180	135
22	18	23	2,250	2,970	1,280	1,150	870	0	570	462	442	442	437	185	130
61	1	-12	1,465	2,640	1,270	765	855	0	518	469	450	452	457	208	128
61	2	-11	1,080	2,660	1,330	790	885	0	642	442	428	430	395	196	125
37	3	8	1,700	3,180	1,590	940	980	0	441	376	353	356	353	----	124
22	19	23	2,155	3,880	1,390	1,250	970	0	418	363	348	358	348	158	111
22	20	36	2,785	4,170	1,950	1,430	1,290	0	388	350	327	328	333	150	111
22	21	37	2,580	4,680	1,865	1,985	1,280	0	383	337	322	325	327	155	110

PART 4.- FUSELAGE AIR TEMPERATURES, AIR-FLOW RATES, & DOUBLER TEMPERATURES.

TABLE III (CONTINUED)



LEGEND

A - AIR THERMOCOUPLE
M - STRUCTURE THERMOCOUPLE
P_S - PRESSURE ORIFICES (STATIC)
P_T - PRESSURE ORIFICES (TOTAL)

DASH NUMBER AFTER THERMOCOUPLE OR PRESSURE ORIFICE NUMBER DENOTES TYPE OF MOUNTING.

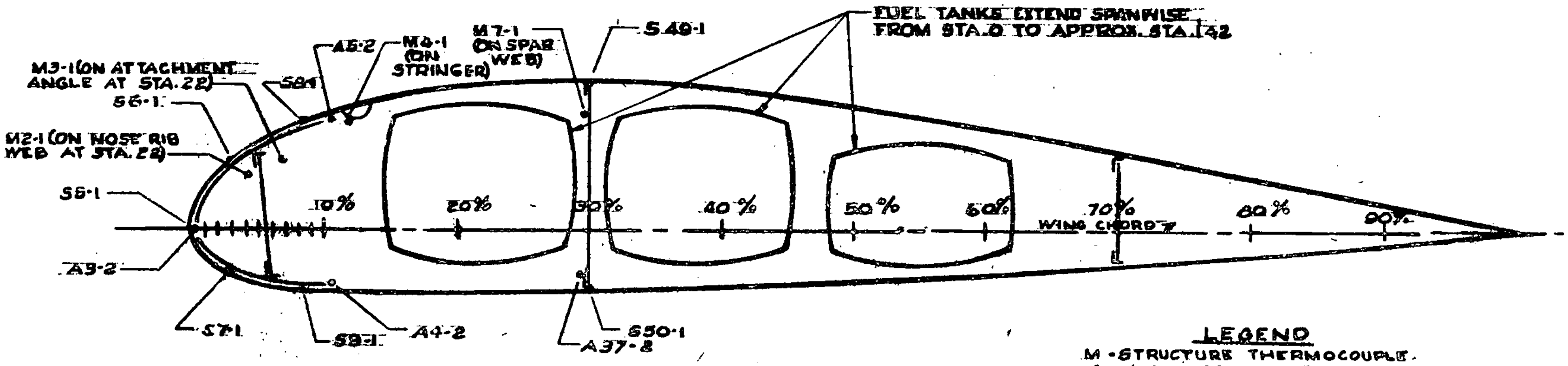
FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

THEMOCOUPLES NOS. A68 TO A70 INCL. ON RIGHT HAND NACELLE ONLY.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	VENTURI FLOW RATES (LB/HR) ① NO.1	② NO.2	TEMPERATURE (°F) A61	A62	A63	A95	A65	A66	A67	A94	M10	M9	A68	A69	A70	A71	A72	A73
22	16	32	5,880	4,450	299	304	280	294	393	408	383	358	170	86	594	---	554	323	309	---
22	17	30	5,330	3,790	307	299	280	309	403	422	393	373	180	91	608	---	550	319	309	---
22	18	23	4,950	3,670	323	314	289	314	432	437	422	413	185	91	623	---	580	333	328	---
61	1	-12	4,390	2,805	381	367	322	384	---	467	416	462	282	70	539	539	629	311	375	385
61	2	-11	5,040	3,250	338	333	302	338	---	410	317	404	250	68	608	619	701	274	318	330
37	3	8	5,740	4,250	264	274	---	268	321	348	320	308	214	71	477	---	461	244	239	---
22	19	23	6,430	4,505	250	250	230	240	328	348	330	323	150	76	447	---	442	260	250	---
22	20	36	7,150	4,670	240	245	215	235	314	338	314	314	145	70	413	---	403	255	245	---
22	21	37	7,290	5,150	233	243	213	253	312	327	312	300	150	80	422	---	393	258	243	---

1.-FLOW RATE CALCULATION BASED ON TEMPERATURE A62 AT VENTURI NO. 1
2.-FLOW RATE CALCULATION BASED ON TEMPERATURE A66 AT VENTURI NO. 2.

PART 5.- HEAT-EXCHANGER AIR TEMPERATURES & FLOW RATES
TABLE III (CONTINUED)



STATION 24

LEGEND

M - STRUCTURE THERMOCOUPLE.
A - AIR THERMOCOUPLE.
S - SKIN THERMOCOUPLE.

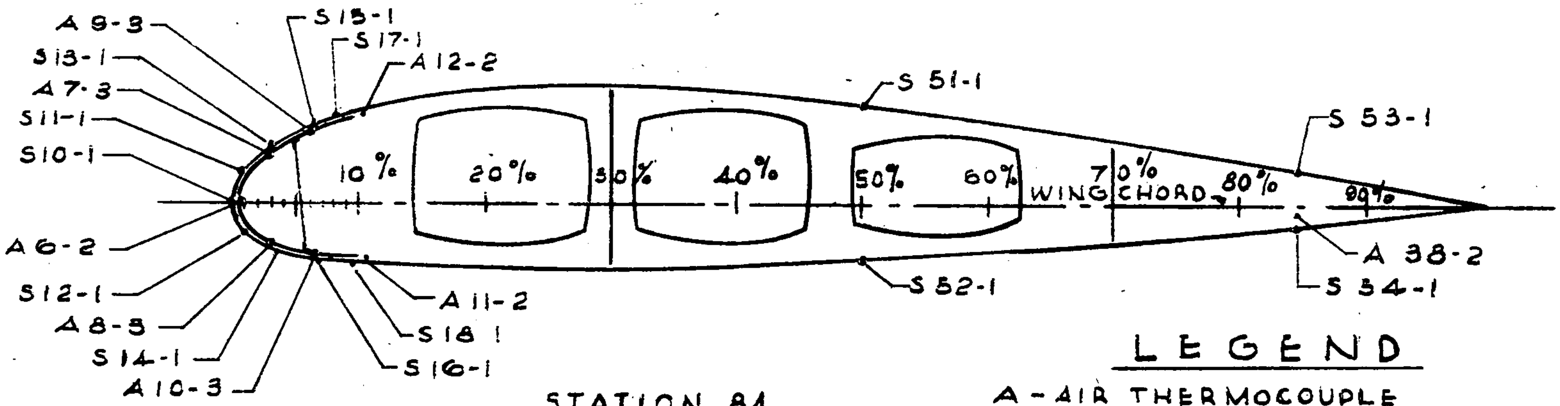
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS SEE FIGURE 9.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)														
			S49	S8	S6	S5	S7	S9	S50	A5	A3	A4	A37	M2	M3	M4	M7
22	16	32	52	81	106	170	119	91	41	111	230	106	52	215	170	91	66
22	17	30	49	76	101	170	116	91	41	116	235	111	57	220	157	91	65
22	18	23	41	72	100	175	120	86	31	111	240	106	46	220	175	90	65
61	1	-12	20	77	125	174	144	89	3	104	267	103	20	252	195	71	40
61	2	-11	23	88	130	171	140	93	6	109	255	104	17	240	178	78	42
37	3	8	32	61	94	141	100	71	22	91	209	81	32	199	144	71	47
22	19	23	41	62	86	145	91	72	36	96	195	91	46	185	147	80	58
22	20	36	45	72	90	140	95	76	41	100	190	94	52	178	140	85	60
22	21	37	50	75	90	145	95	85	45	100	188	95	50	178	145	90	65

PART 6.-WING OUTER PANEL (STATION 24) SKIN, STRUCTURE, AND AIR TEMPERATURES.

TABLE III (CONTINUED)



STATION 84

LEGEND

A - AIR THERMOCOUPLE

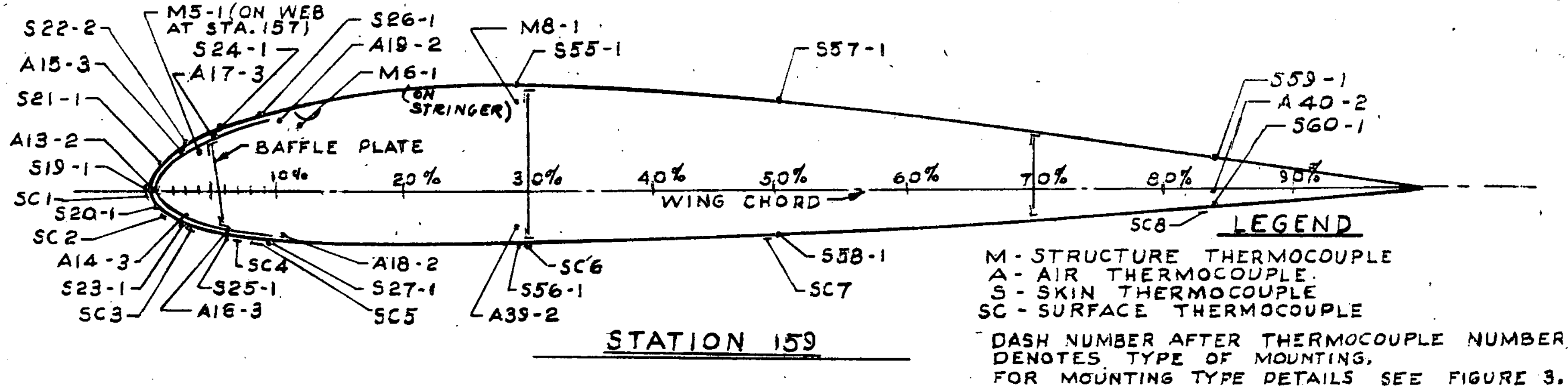
S - SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS SEE FIGURE 8.

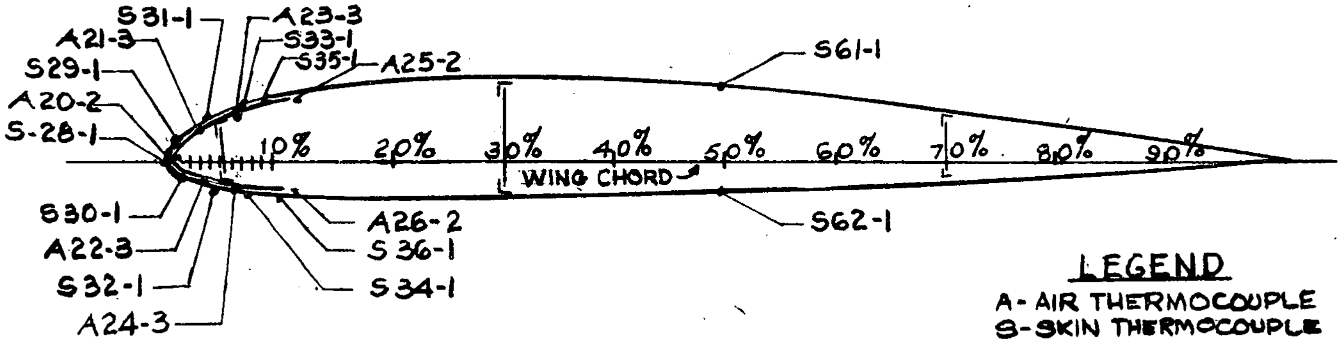
FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)																				
			S53	S51	S17	S15	S13	S11	S10	S12	S14	S16	S18	S52	S34	A12	A9	A7	A6	A8	A10	A11	A38
22	16	32	36	41	91	118	155	155	210	160	180	123	101	41	36	128	158	183	245	185	170	128	36
22	17	30	34	37	91	116	160	150	225	155	185	125	106	37	38	130	155	190	248	190	175	130	36
22	18	23	24	26	81	111	155	155	220	160	180	128	96	26	24	125	155	190	250	190	173	125	26
61	1	-12	9	3	55	88	152	144	165	153	177	131	91	6	0	88	122	185	265	190	170	109	12
61	2	-11	5	3	61	98	147	142	161	151	176	98	75	5	1	92	130	176	252	185	165	100	3
37	3	8	17	17	61	71	101	114	156	121	128	71	71	17	17	86	101	146	214	156	---	88	22
22	19	23	26	32	67	91	130	130	180	135	145	81	80	32	26	111	135	160	200	162	145	106	26
22	20	36	36	35	81	96	130	136	178	135	150	86	86	35	36	110	130	155	200	160	140	103	31
22	21	37	37	38	85	95	130	130	178	135	150	85	90	38	37	110	130	155	198	160	145	103	41

PART 7.- WING OUTER PANEL (STATION 84) SKIN AND AIR TEMPERATURES.
TABLE III (CONTINUED)



FLIGHT Nº	RUN Nº	AMBIENT AIR (°F.)	TEMPERATURE (F°)																										
			S59	S57	S55	S26	S24	S22	S21	S19	S20	S23	S25	S27	S56	S58	S60	A19	A17	A15	A13	A14	A16	A18	A40	A39	M6	M5	M8
22	16	32	36	41	50	86	106	150	150	150	160	160	130	96	45	41	36	125	160	185	230	175	175	128	36	62	96	117	73
22	17	30	34	37	45	86	101	150	150	155	155	166	135	101	42	37	34	125	155	185	235	180	180	130	36	67	96	140	70
22	18	23	24	26	36	72	101	155	145	160	154	165	135	101	36	26	24	120	160	190	240	185	180	125	26	57	91	154	63
61	1	-12	2	5	16	99	135	162	150	156	154	162	151	124	11	3	-1	130	165	200	258	175	172	130	1	34	77	223	42
61	2	-11	1	5	18	116	133	156	145	151	154	164	152	124	11	3	0	133	166	188	246	171	174	128	-1	30	91	212	40
37	3	8	17	17	27	58	66	96	106	111	116	96	71	54	22	15	17	86	111	141	199	134	121	81	22	41	71	---	47
22	19	23	26	32	36	67	86	125	125	130	134	121	91	67	34	32	26	101	125	156	195	150	145	96	26	52	76	134	55
22	20	36	36	35	45	76	91	125	130	130	135	120	91	75	40	35	36	106	130	155	193	145	140	101	31	57	81	135	60
22	21	37	37	38	50	75	90	130	130	130	135	125	92	80	45	38	37	111	135	160	188	150	140	106	41	60	85	135	65

PART 8.- WING OUTER PANEL (STATION 159) SKIN, STRUCTURE, & AIR TEMPERATURES. TABLE III - (CONTINUED)

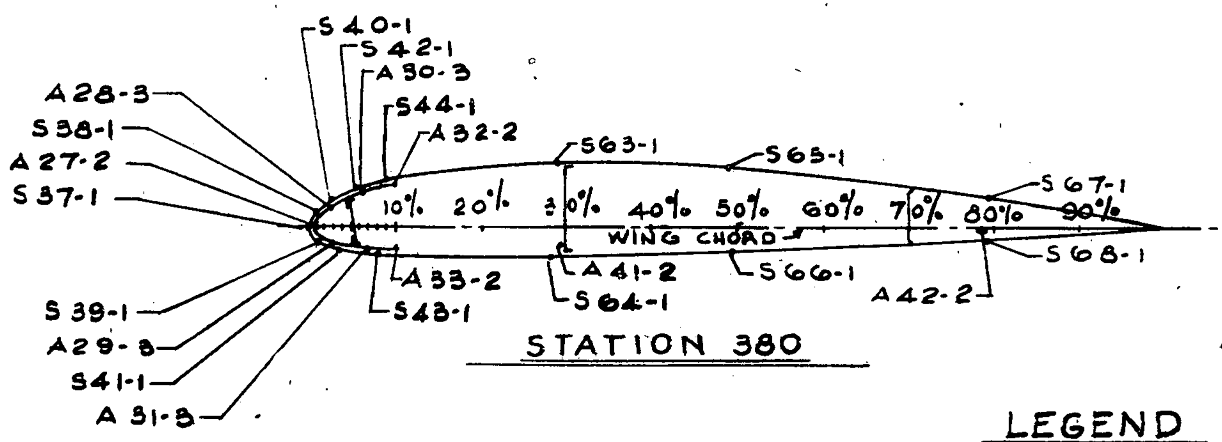


STATION 290

LEGEND
A- AIR THERMOCOUPLE
S- SKIN THERMOCOUPLE
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.
FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT No.	RUN No.	AMBIENT AIR (°F)	TEMPERATURE (°F)																	
			S61	S35	S33	S31	S29	S28	S30	S32	S34	S36	S62	A25	A23	A21	A20	A22	A24	A26
22	16	32	41	140	155	175	165	160	170	175	160	135	41	158	190	190	240	200	180	158
22	17	30	37	140	160	175	165	160	175	175	162	140	37	155	190	195	245	200	185	155
22	18	23	28	135	160	175	155	155	160	175	165	135	28	160	190	195	255	200	185	150
61	1	-12	4	124	156	172	160	160	158	175	156	140	1	129	188	192	269	202	176	162
61	2	-11	4	135	155	166	156	156	158	174	155	120	1	144	191	185	258	195	176	146
37	3	8	22	76	94	131	126	126	131	136	96	76	27	101	151	161	214	174	131	114
22	19	23	32	116	132	150	135	135	140	152	132	96	32	130	160	165	205	172	155	125
22	20	36	35	120	130	145	135	135	140	145	130	95	35	135	160	163	203	165	150	125
22	21	37	38	120	135	145	135	135	145	145	130	100	38	125	160	165	198	170	150	120

PART 9.-WING OUTER PANEL (STATION 290) SKIN AND AIR TEMPERATURES.
TABLE III- (CONTINUED.)



LEGEND

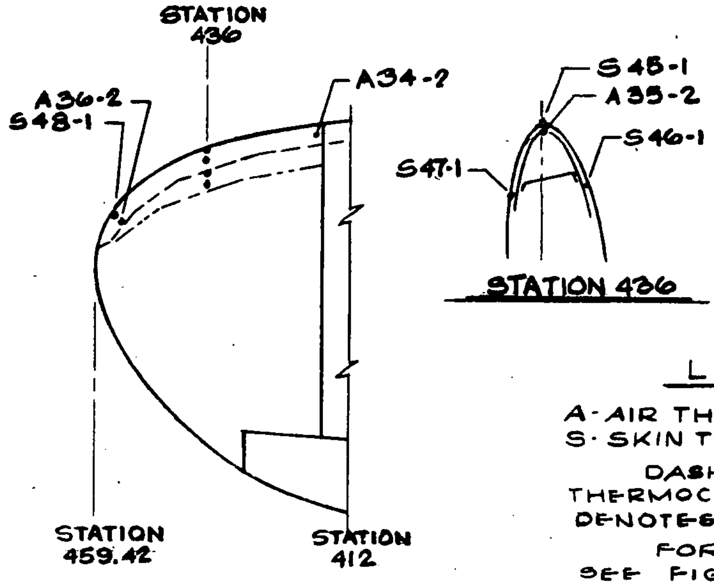
A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)																							
			S67	S65	S63	S44	S42	S40	S38	S37	S39	S41	S43	S64	S66	S68	A32	A30	A28	A27	A29	A31	A33	A41	A42
22	16	32	36	41	50	106	130	175	188	155	185	170	121	55	41	36	145	185	210	250	210	170	170	81	36
22	17	30	34	37	47	106	135	175	190	150	185	170	132	50	37	34	140	190	210	250	210	170	165	80	36
22	18	23	24	28	41	101	140	178	185	145	180	174	125	43	28	24	140	190	215	265	215	175	165	76	26
61	1	-12	5	5	20	129	147	182	187	157	187	176	157	20	1	0	139	196	215	289	215	184	182	58	1
61	2	-11	4	5	21	125	140	174	182	146	180	166	---	21	4	-1	145	186	208	268	208	162	154	53	-1
37	3	8	17	22	32	76	101	146	156	122	149	128	81	32	22	17	116	154	171	221	184	134	133	56	22
22	19	23	26	32	41	81	101	149	156	125	150	133	81	41	32	26	116	155	175	210	174	125	130	67	26
22	20	36	36	35	46	88	110	148	150	130	145	130	88	46	35	36	110	155	175	205	172	130	135	70	31
22	21	37	37	38	53	90	115	150	155	130	145	135	90	53	38	37	115	160	174	193	173	150	125	75	41

PART 10.-WING OUTER PANEL (STATION 380) SKIN AND AIR TEMPERATURES. TABLE III (CONTINUED)



WING TIP

LEGEND

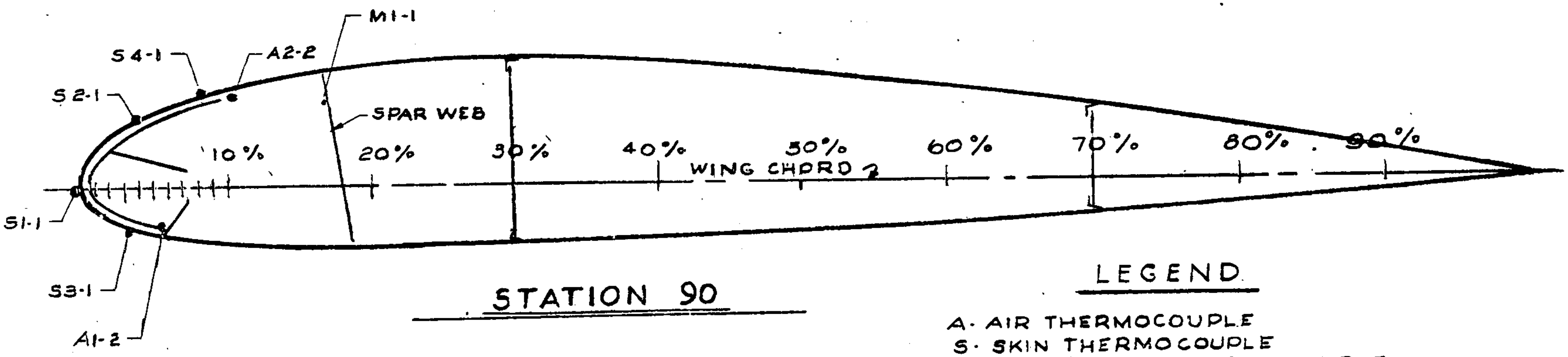
A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING DETAILS SEE FIGURE 3.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	TEMPERATURE (°F)						
			A34	S48	A36	S46	S45	S47	A35
22	16	32	230	86	210	140	101	140	220
22	17	30	230	86	210	162	101	150	225
22	18	23	240	81	215	165	91	160	230
61	1	-12	251	---	218	190	80	181	240
61	2	-11	255	50	210	171	75	166	233
37	3	8	191	56	---	136	76	134	---
22	19	23	190	57	175	136	81	135	185
22	20	36	185	67	175	130	85	125	180
22	21	37	188	70	174	135	88	135	180

PART II.-WING TIP SKIN & AIR TEMPERATURES.
TABLE III (CONTINUED)



STATION 90

LEGEND

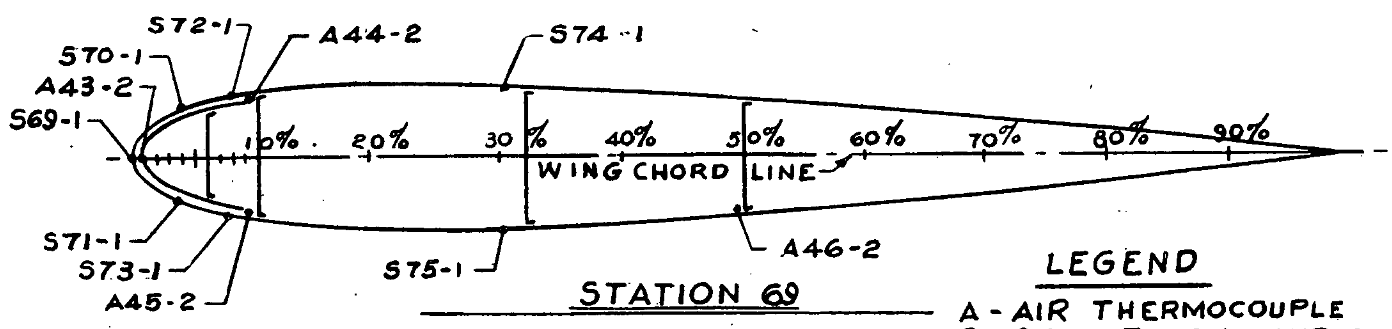
A- AIR THERMOCOUPLE
S- SKIN THERMOCOUPLE
M- STRUCTURE THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F.)	TEMPERATURE (°F)						
			S4	S2	S1	S3	A2	A1	M1
22	16	32	40	41	70	57	46	122	57
22	17	30	36	41	72	57	41	121	67
22	18	23	31	31	67	52	36	116	57
61	1	-12	36	65	183	174	32	239	37
61	2	-11	42	68	174	161	38	230	34
37	3	8	37	47	151	121	56	199	47
22	19	23	31	36	57	41	37	111	52
22	20	36	31	36	57	46	41	111	52
22	21	37	40	45	65	55	30	120	55

PART 12.- WING CENTER PANEL (STATION 90) SKIN AND AIR TEMPERATURES.
TABLE III (CONTINUED)

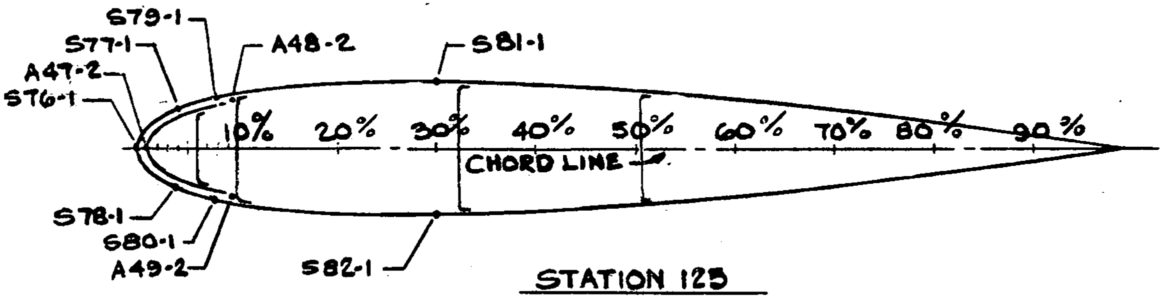


LEGEND

A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING. FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)										
			S74	S72	S70	S69	S71	S73	S75	A44	A43	A45	A46
22	16	32	36	160	225	190	212	91	36	157	358	140	40
22	17	30	31	160	230	192	215	101	36	155	383	140	36
22	18	23	21	158	230	190	215	100	21	140	383	132	21
61	1	-12	2	125	193	156	176	111	0	97	367	93	-2
61	2	-11	4	124	190	151	165	67	4	93	349	68	-4
37	3	8	18	81	166	131	146	61	22	71	299	76	17
22	19	23	21	124	190	164	175	76	21	121	314	116	26
22	20	36	36	120	190	165	170	86	36	125	299	130	36
22	21	37	40	120	188	162	170	85	40	123	288	124	36

PART 13.- STABILIZER (STATION 69) SKIN & AIR TEMPERATURES.
TABLE III - (CONTINUED)



STATION 125

LEGEND

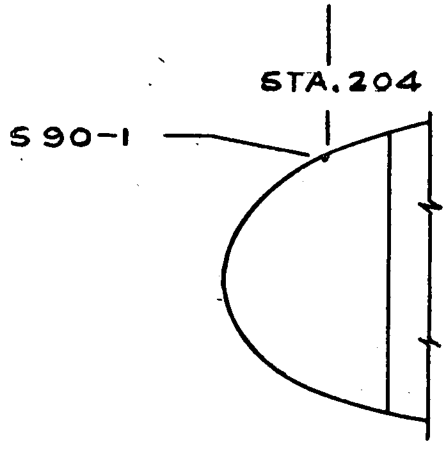
A · AIR THERMOCOUPLE
S · SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

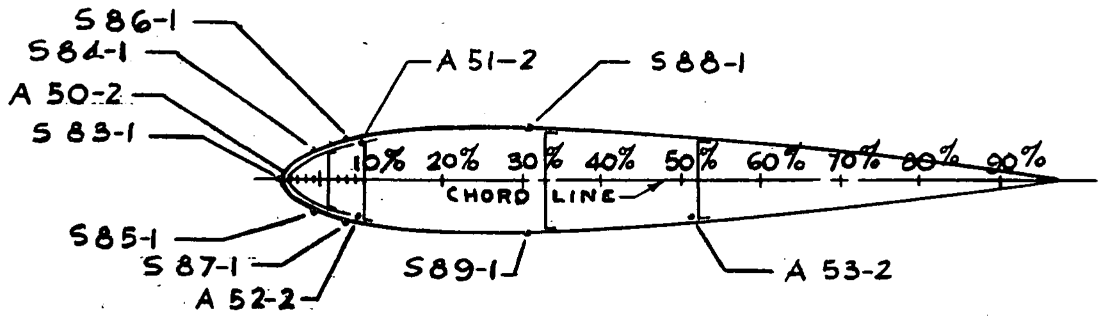
FOR MOUNTING DETAILS SEE FIGURE 3.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	TEMPERATURE (°F)									
			S81	S79	S77	S76	S78	S80	S82	A48	A47	A49
22	16	32	42	130	185	155	200	101	36	152	323	170
22	17	30	41	133	185	150	210	116	41	151	330	178
22	18	23	32	121	180	152	205	116	31	145	338	165
61	1	-12	9	100	154	123	180	120	2	110	328	157
61	2	-11	9	102	154	118	169	69	5	118	318	133
37	3	8	22	86	138	111	151	71	22	161	264	121
22	19	23	31	106	155	121	165	80	26	125	274	139
22	20	36	35	105	155	130	160	80	41	130	263	140
22	21	37	45	110	153	130	160	83	45	130	253	135

PART 14.- STABILIZER (STATION 125) SKIN & AIR TEMPERATURES.
TABLE III (CONTINUED)



TIP



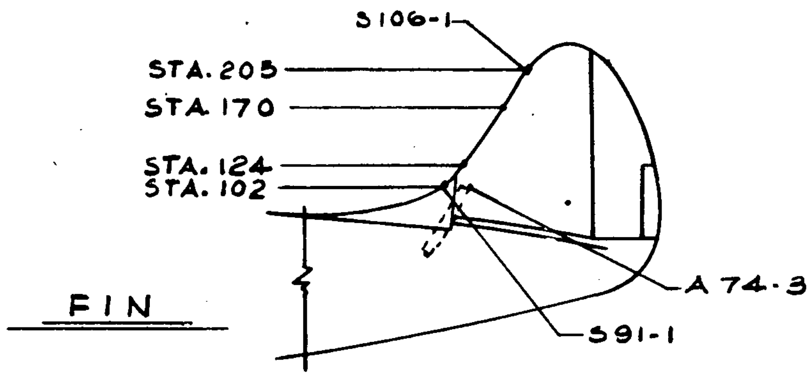
STATION 171

LEGEND

A AIR THERMOCOUPLE
S SKIN THERMOCOUPLE
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.
FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT NO	RUN NO	AMBIENT AIR (°F)	TEMPERATURE (°F)											
			S90	S88	S86	S84	S83	S85	S87	S89	A51	A50	A52	A53
22	16	32	136	42	126	178	170	160	106	42	180	302	165	52
22	17	30	130	41	129	175	165	165	101	41	180	307	165	54
22	18	23	130	32	116	170	166	165	91	32	177	314	160	41
61	1	−12	93	10	103	145	131	144	90	5	147	290	134	17
61	2	−11	110	9	95	145	130	135	65	9	146	280	125	16
37	3	8	101	22	81	136	121	126	71	22	131	241	121	32
22	19	23	111	31	101	149	135	132	76	31	150	255	134	41
22	20	36	116	35	100	155	145	135	80	35	150	248	140	40
22	21	37	120	45	105	150	145	132	85	45	150	238	140	53

PART 15.—STABILIZER (TIP AND STATION 171) SKIN AND AIR TEMPERATURES.
TABLE III (CONTINUED)



FIN

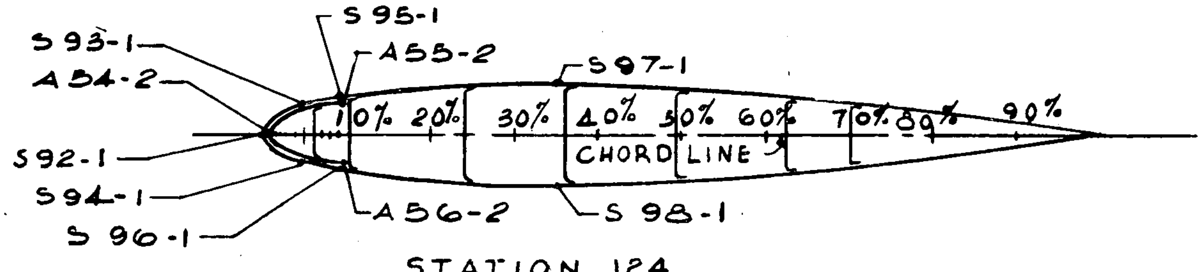
LEGEND

A - AIR THERMOCOUPLE

S - SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

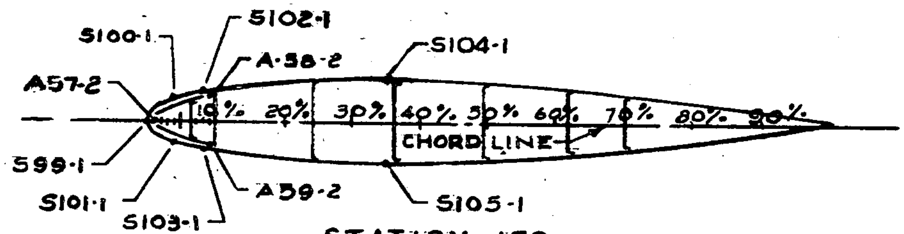
FOR MOUNTING TYPE DETAILS SEE FIGURE 3.



STATION 124

FLIGHT No.	RUN No.	AMBIENT AIR (°F)	TEMPERATURE (°F)												
			S91	S106	A74	S97	S95	S93	S92	S94	S96	S98	A55	A54	A56
22	16	32	36	172	393	44	120	180	210	170	106	44	170	363	164
22	17	30	31	174	413	41	120	188	205	172	115	41	174	388	165
22	18	23	21	165	422	31	106	180	210	160	101	31	165	388	155
61	1	-12	-9	162	434	-3	85	174	202	158	80	-3	152	390	170
61	2	-11	-6	151	408	2	83	166	190	150	80	1	148	378	190
37	3	8	22	131	343	22	91	156	171	141	86	24	151	333	134
22	19	23	26	145	338	31	96	150	175	140	91	31	145	314	130
22	20	36	35	145	314	36	96	150	174	140	91	36	145	299	135
22	21	37	35	145	319	40	105	155	175	140	100	40	150	299	145

PART 16.- FIN (DORSAL, TIP AND STATION 124) SKIN AND AIR TEMPERATURES. TABLE III (CONTINUED)



STATION 170

LEGEND

A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)									
			S104	S102	S100	S99	S101	S103	S105	A58	A57	A59
22	16	32	46	125	192	150	173	123	46	203	347	160
22	17	30	41	121	190	132	174	122	41	198	367	165
22	18	23	31	116	190	155	173	115	31	190	353	148
61	1	-12	7	93	197	166	206	32	7	156	354	130
61	2	-11	5	88	170	156	---	32	7	152	344	109
37	3	8	32	96	156	136	136	91	27	166	294	121
22	19	23	36	106	165	130	145	101	36	165	289	132
22	20	36	41	105	160	135	140	101	36	170	278	135
22	21	37	41	108	160	130	140	105	45	170	175	140

PART 17.- FIN (STATION 170) SKIN AND AIR TEMPERATURES.

TABLE III (CONCLUDED)

DATE OF FLIGHT	FLIGHT Nº.	RUN Nº.	PRESSURE ALTITUDE (FT.)	CORRECTED INDICATED AIRSPEED (MPH)	AMBIENT AIR (°F)	(2) AIRPLANE OPERATING CONDITIONS	SEVERITY OF ICING	TYPE OF ICING
1-30-44	29	1	6,500	172	30	1900-R.P.M.-CRUISE	MODERATE	GLAZE
2-7-44	34	1	4,920	163	22	1900-R.P.M.-CRUISE	MODERATE	GLAZE & RIME
2-14-44	41	5	3,260	184	20	1900-R.P.M.-CRUISE	MODERATE	GLAZE
2-23-44	49	1	13,160	143	6	1900-R.P.M.-CRUISE	HEAVY-ICE & SNOW	GLAZE & SNOW
3-1-44	50	4	5,600	162	25	1900-R.P.M.-CRUISE	HEAVY	ROUGH GLAZE
3-2-44	51	1	4,750	170	29	1900-R.P.M.-CRUISE	MODERATE	GLAZE
3-13-44	57	1	8,000	160	32	1900-R.P.M.-CRUISE	MODERATE	GLAZE
3-15-44	59	1	2,825	167	28	1900-R.P.M.-CRUISE	LIGHT	GLAZE
3-22-44	(1) 63	1	3,925	158	27	1900-R.P.M.-CRUISE	LIGHT	GLAZE
3-22-44	65	1	4,000	171	26	1900-R.P.M.-CRUISE	LIGHT	GLAZE
1-30-44	29	2	5,520	149	30	MAX.RANGE-CRUISE	MODERATE	GLAZE
2-7-44	34	2	4,300	132	22	MAX.RANGE-CRUISE	LIGHT	GLAZE & RIME
2-14-44	41	6	3,500	162	20	MAX.RANGE-CRUISE	MODERATE	GLAZE

(1) RIGHT INBOARD HEAT EXCHANGER OFF. (2) SEE TABLE I.

NOTE: ALL FLIGHTS WERE CONDUCTED WITHIN 500 MILES OF MINNEAPOLIS, MINNESOTA EXCEPT FLIGHT 49 WHICH WAS A FERRY FLIGHT FROM MOFFETT FIELD, CALIFORNIA TO MINNEAPOLIS, MINNESOTA.

PART I.- OPERATING CONDITIONS

TABLE IV

PERFORMANCE OF C-46 THERMAL ICE-PREVENTION SYSTEM DURING FULL-HEAT-FLOW TESTS IN NATURAL-ICING CONDITIONS

FLIGHT NO	RUN NO	EXCHANGER HEAT FLOWS (1000 BTU/HR)			HEAT FLOWS TO HEATED SURFACES (1000 BTU/HR)			
		① LEFT OUTBOARD	② LEFT INBOARD	③ RIGHT INBOARD	LEFT WING OUTER PANEL	RIGHT STABILIZER	FIN	TO SECONDARY EXCHANGER
29	1	349	419	143	349	78	129	80
34	1	348	266	171	348	77	126	87
41	5	397	471	161	397	88	145	95
49	1	340	308	163	340	79	126	89
50	4	423	399	189	423	96	158	101
51	1	414	415	187	414	96	157	109
57	1	300	338	140	300	58	143	81
59	1	414	402	173	414	119	158	87
63	1	420	449	0	420	61	97	64
65	1	415	387	151	415	89	148	91
29	2	267	267	143	267	60	135	68
34	2	271	278	143	271	64	100	67
41	6	236	359	154	236	73	119	73

① - TEMPERATURE RISE USED TO CALCULATE HEAT TRANSFERRED = [(A_{62}) - (AMBIENT-AIR TEMPERATURE)] (°F).

② - TEMPERATURE RISE USED TO CALCULATE HEAT TRANSFERRED = [(A_{56}) - (AMBIENT-AIR TEMPERATURE)] (°F).

③ - PORTION OF RIGHT INBOARD HEAT-EXCHANGER HEAT FLOW MEASURED AT VENTURI NO. 3.

PART 2.-HEAT DISTRIBUTION.

TABLE IV (CONTINUED).

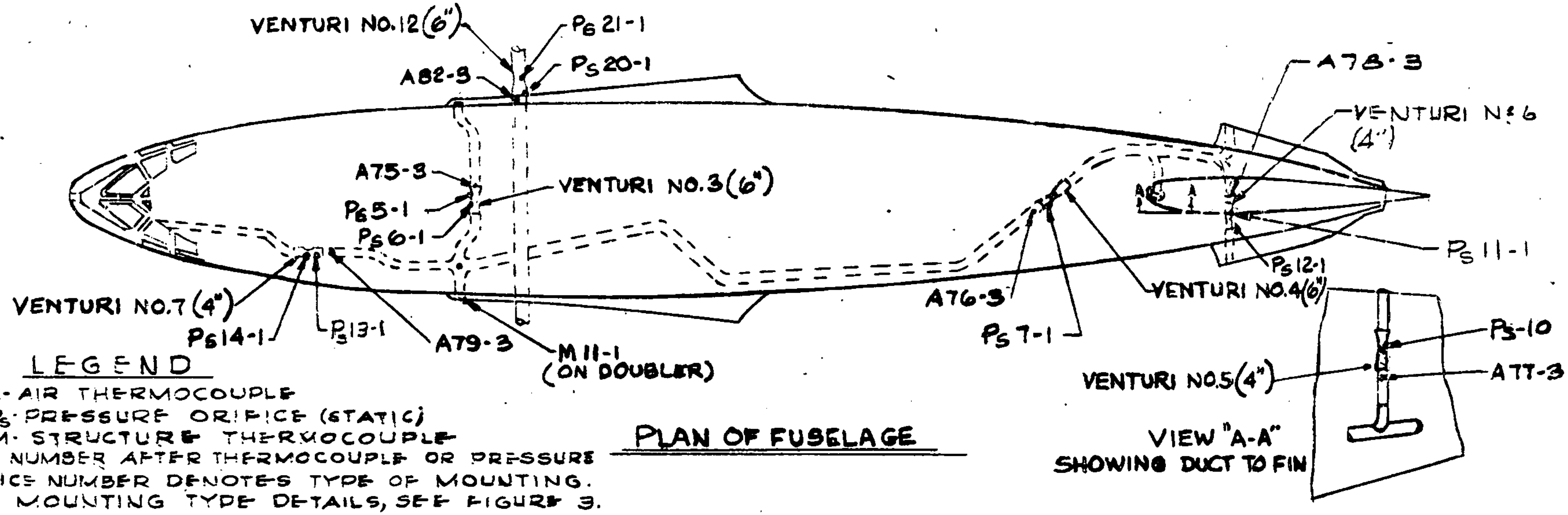
FLIGHT NO.	RUN NO.	AVERAGE HEAT DELIVERED PER SQUARE FT. OF DOUBLE SKIN LEADING-EDGE SURFACE (BTU/HR)			AVERAGE HEAT FLOW THRU HEATED SKIN SURFACE PER SQUARE FT. OF DOUBLE-SKIN SURFACE (BTU/HR)			RATIO OF HEAT FLOW THRU HEATED SKIN SURFACE TO HEAT DELIVERED.			AVERAGE TEMP. RISE OF WING OUTER PANEL, 0% CHORD (°F)
		LEFT WING OUTER PANEL	RIGHT STABILIZER	VERTICAL FIN.	(1) LEFT WING OUTER PANEL	(2) RIGHT STABILIZER	(3) VERTICAL FIN.	LEFT WING OUTER PANEL	RIGHT STABILIZER	VERTICAL FIN.	
29	1	3,300	3,670	7,180	1490	1,440	3,580	0.45	0.39	0.50	66.
34	1	3,290	3,570	7,040	1,510	1,930	3,480	.46	.54	.50	69.8
41	5	3,760	4,100	8,100	1,600	2,160	3,880	.42	.53	.48	85.8
49	1	3,220	3,670	7,000	1,380	1,830	3,390	.43	.50	.48	96.6
50	4	4,000	4,470	8,790	1,830	2,290	4,610	.46	.51	.53	82.4
51	1	3,920	4,500	8,750	1,780	2,540	4,530	.46	.56	.52	80.8
57	1	2,840	4,110	8,060	1,810	2,070	4,300	.64	.50	.53	73.6
59	1	3,920	5,580	8,800	1,670	2,170	4,620	.43	.39	.53	95.8
63	1	3,980	2,830	5,400	1,530	1,250	2,900	.38	.44	.54	135
65	1	3,920	4,150	8,280	1,570	1,970	4,340	.40	.48	.52	113.4
29	2	2,520	2,800	7,510	1,170	1,420	2,840	.46	.51	.38	85.4
34	2	2,570	3,000	5,580	1,070	1,310	2,770	.42	.44	.50	92.4
41	6	2,240	3,400	6,650	1480	1,680	3,340	.66	.49	.50	85.8

(1) CALCULATED ON BASIS OF AVERAGE TEMPERATURE DROP OF THE HEATED AIR IN THE CORRUGATIONS AT STATIONS 24, 84, 159, 290 AND 380 AND THE TOTAL AIRFLOW RATE FROM LEFT OUTBOARD EXCHANGER

(2) CALCULATED ON BASIS OF AVERAGE TEMPERATURE DROP OF THE HEATED AIR IN THE CORRUGATIONS AT STATIONS 69, 125, AND 171, AND THE TOTAL AIRFLOW RATE TO THE RIGHT STABILIZER.

(3) CALCULATED ON BASIS OF AVERAGE TEMPERATURE DROP OF THE HEATED AIR IN THE CORRUGATIONS AT STATIONS 124 AND 170 AND THE TOTAL AIRFLOW RATE TO THE VERTICAL FIN.

PART 3.– SURFACE HEATING VALUES.
TABLE IV (CONTINUED)

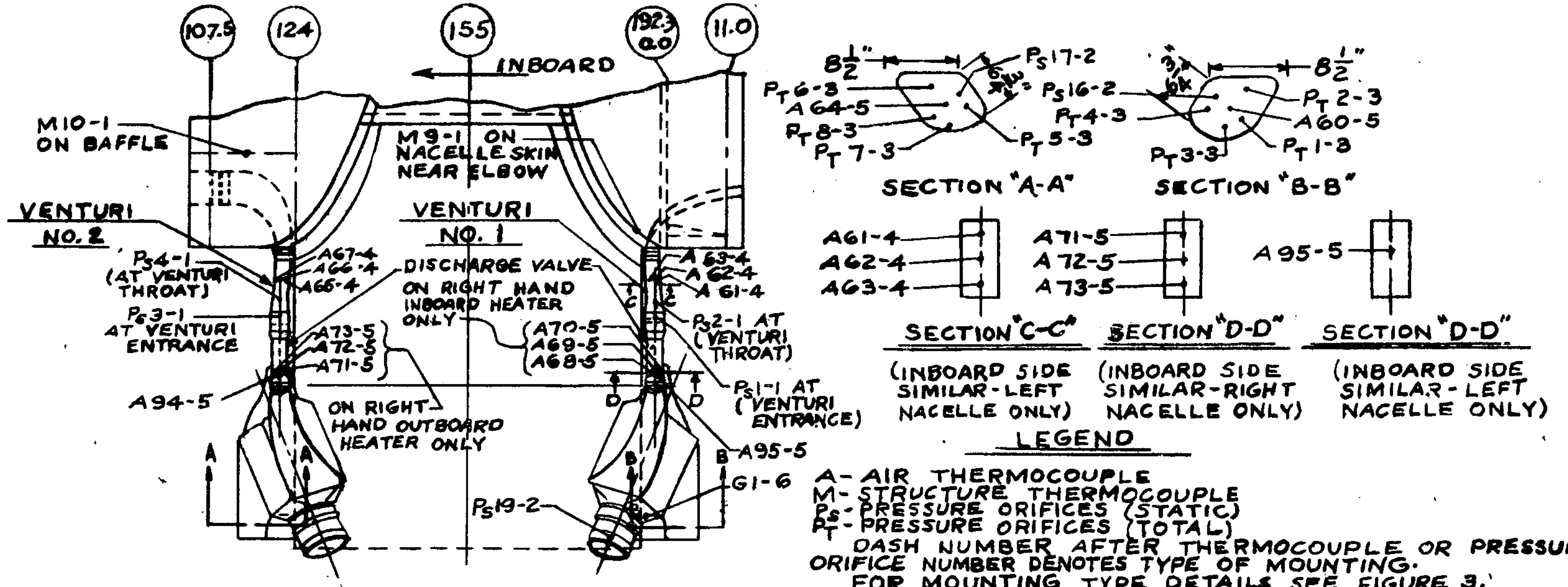


LEGEND

A - AIR THERMOCOUPLE
P_S - PRESSURE ORIFICE (STATIC)
M - STRUCTURE THERMOCOUPLE
DASH NUMBER AFTER THERMOCOUPLE OR PRESSURE ORIFICE NUMBER DENOTES TYPE OF MOUNTING. FOR MOUNTING TYPE DETAILS, SEE FIGURE 3.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	VENTURI FLOW RATES (LB/HR)						TEMPERATURE, (°F)						
			NO.3	NO.4	NO.5	NO.6	NO.7	NO.12	A75	A76	A77	A78	A79	A82	M11
29	1	30	1,430	3,540	1,670	1,015	1,095	0	435	362	347	347	330	174	138
34	1	22	1,880	3,470	1,680	1,015	1,100	0	376	350	331	332	345	166	124
41	5	20	1,795	3,780	1,810	1,080	1,125	0	387	364	350	354	367	152	122
49	1	6	1,445	2,625	1,240	770	850	0	464	437	420	424	434	188	176
50	4	25	1,630	3,295	1,585	950	1,005	0	495	447	450	436	433	178	153
51	1	29	1,670	3,340	1,600	975	1,080	0	483	447	429	432	438	178	126
57	1	32	1,295	2,910	1,405	850	1,000	0	469	468	450	453	364	198	99
59	1	28	1,570	3,600	1,730	1,025	1,150	0	473	414	400	403	373	180	142
63	1	27	0	3,125	1,450	875	915	0	297	313	302	306	315	192	93
65	1	26	1,195	3,580	1,720	1,010	1,140	0	535	395	379	385	352	195	130
29	2	30	1,830	3,065	1,470	875	1,005	0	350	322	307	312	310	162	135
34	2	22	1,870	3,060	1,430	890	955	0	337	320	310	310	312	135	125
41	6	20	1,720	3,420	1,635	975	1,050	0	385	337	320	327	307	160	120

PART 4.- FUSELAGE AIR TEMPERATURES, AIR-FLOW RATES, & DOUBLER TEMPERATURES. TABLE IV (CONTINUED)



LEGEND

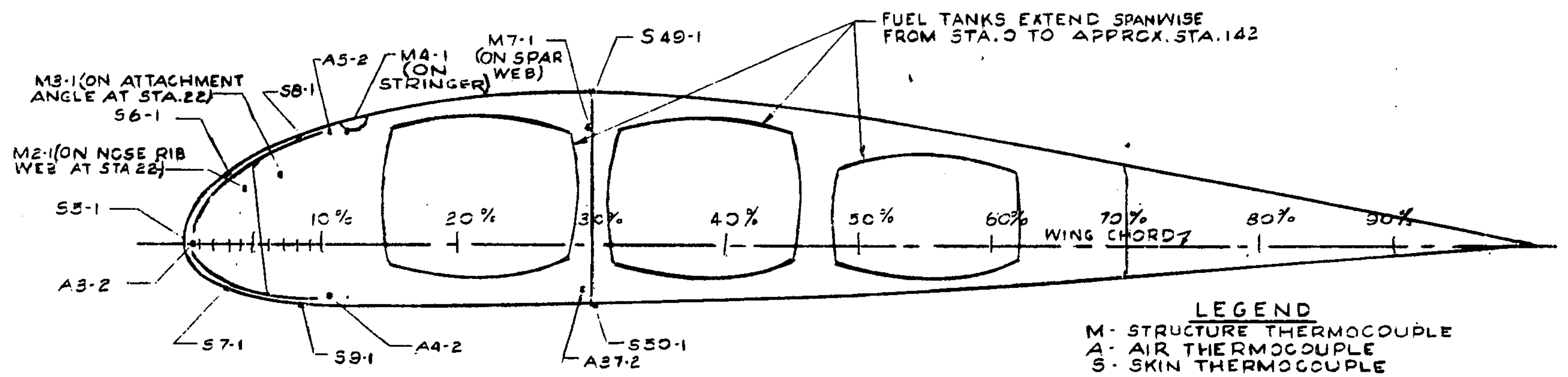
A- AIR THERMOCOUPLE
M- STRUCTURE THERMOCOUPLE
P_S- PRESSURE ORIFICES (STATIC)
P_T- PRESSURE ORIFICES (TOTAL)

DASH NUMBER AFTER THERMOCOUPLE OR PRESSURE ORIFICE NUMBER DENOTES TYPE OF MOUNTING. FOR MOUNTING TYPE DETAILS SEE FIGURE 3. THERMOCOUPLES NOS. A-68 TO A-73 INCL. ON RIGHT HAND NACELLE ONLY.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	VENTURI FLOW RATES (LB/HR)		TEMPERATURE (°F)															
			①NO. 1	②NO. 2	A61	A62	A63	A95	A65	A66	A67	A94	M10	M9	A68	A69	A70	A71	A72	A73
29	1	30	5,990	5,290	272	270	---	262	330	356	327	287	213	80	496	---	448	290	290	---
34	1	22	5,950	4,725	264	263	---	266	338	255	322	292	218	75	440	---	375	258	243	---
41	5	20	6,690	5,410	266	265	---	267	---	377	362	292	227	74	505	---	390	---	276	---
49	1	6	4,480	2,790	318	318	265	325	---	454	402	363	267	82	475	270	530	275	293	292
50	4	25	5,810	3,770	339	324	283	333	---	456	427	446	275	84	523	245	581	291	320	331
51	1	29	6,040	3,860	229	311	283	335	---	467	438	467	285	85	497	242	564	280	305	321
57	1	32	5,700	3,820	264	250	217	347	---	395	354	403	270	90	542	465	562	208	230	265
59	1	28	6,340	4,420	300	297	250	308	---	400	359	394	225	47	498	468	568	252	292	310
63	1	27	5,900	5,790	329	320	381	330	---	346	308	337	195	91	470	487	560	263	250	319
65	1	26	6,180	4,635	312	302	265	313	---	369	332	374	228	83	549	535	623	272	297	226
29	2	30	4,900	3,900	263	255	---	258	312	312	278	238	198	80	405	---	340	275	247	---
34	2	22	4,920	3,710	253	250	---	270	312	330	293	283	198	75	410	---	315	240	223	---
41	6	20	6,360	4,840	263	174	---	268	---	325	290	268	193	80	461	---	388	---	153	---

① FLOW RATE CALCULATION BASED ON TEMPERATURE A-62 AT VENTURI Nº 1.
② FLOW RATE CALCULATION BASED ON TEMPERATURE A-66 AT VENTURI Nº 2.

PART 5.- HEAT-EXCHANGER AIR TEMPERATURES & FLOW RATES
TABLE IV (CONTINUED)



STATION 24

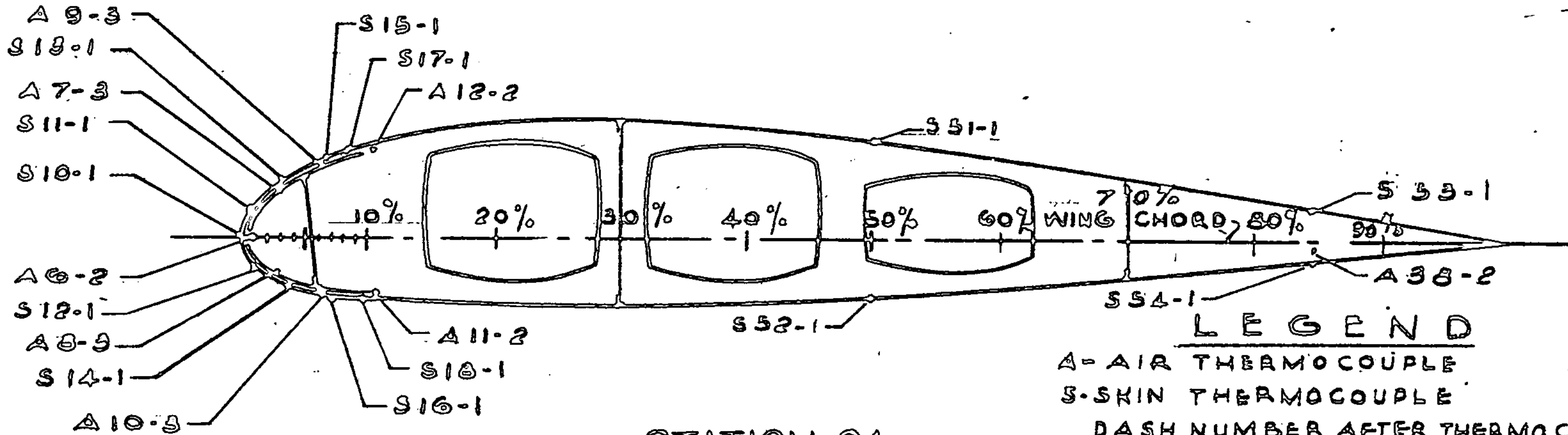
LEGEND
M - STRUCTURE THERMOCOUPLE
A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)														
			S49	S8	S6	S5	S7	S9	S50	A5	A3	A4	A37	M2	M3	M4	M7
29	1	30	45	72	90	98	92	75	44	93	200	86	50	194	160	76	52
34	1	22	40	63	85	97	86	64	37	95	198	82	92	195	146	72	55
41	5	20	42	66	100	120	120	78	30	98	204	90	42	198	152	77	47
49	1	6	25	58	84	120	90	63	21	89	219	78	25	214	171	63	48
50	4	25	40	70	94	119	99	73	37	99	234	84	38	221	174	76	50
51	1	29	45	78	106	128	120	86	40	114	238	101	48	225	178	86	53
57	1	32	48	73	88	117	90	70	35	108	246	92	50	229	182	83	57
59	1	28	53	83	104	133	114	90	49	105	222	93	42	225	173	93	68
63	1	27	53	93	135	174	150	110	57	125	252	118	51	240	185	99	65
65	1	26	52	88	110	163	144	102	42	113	234	104	48	215	172	93	63
29	2	30	45	72	91	130	95	80	42	95	193	90	44	190	150	75	60
34	2	22	42	68	100	125	115	80	36	90	188	85	41	184	145	75	56
41	6	20	38	70	105	120	115	76	36	95	198	90	44	198	155	75	50

PART 6.- WING OUTER PANEL (STATION 24) SKIN, STRUCTURE, AND AIR TEMPERATURES.
TABLE IV (CONTINUED)



LEGEND

A - AIR THERMOCOUPLE

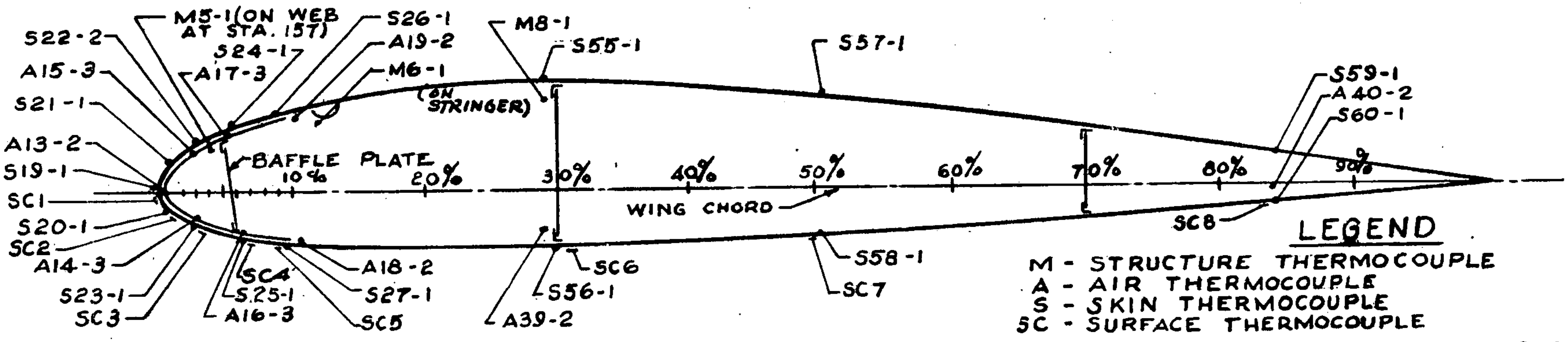
S - SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE DENOTES TYPE OF MOUNTING. FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

STATION 84

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURES (°F)																				
			S53	S51	S17	S15	S13	S11	S10	S12	S14	S16	S18	S52	S54	A12	A9	A7	A6	A8	A10	A11	A35
29	1	30	36	38	68	75	108	91	110	93	118	75	70	38	36	90	100	135	204	138	117	90	40
34	1	22	26	31	57	65	95	90	97	90	115	65	65	30	26	82	100	135	200	135	112	85	30
41	5	20	30	32	65	92	130	137	131	127	158	87	76	34	30	104	116	130	206	150	140	100	28
49	1	6	7	13	48	63	108	92	114	109	130	68	62	13	5	78	97	142	224	146	125	86	16
50	4	25	26	31	64	76	107	104	106	116	132	76	69	31	26	89	110	147	235	158	131	89	26
51	1	29	29	35	71	81	123	141	112	141	154	85	83	35	29	102	123	160	238	166	140	104	32
57	1	32	30	34	68	75	101	85	112	93	120	68	72	34	28	93	110	151	243	154	131	95	37
59	1	28	39	41	78	90	118	130	125	124	142	91	87	41	39	93	109	145	218	153	130	114	28
63	1	27	32	37	103	137	170	164	161	163	182	129	103	41	32	132	164	200	255	196	176	126	33
65	1	26	32	35	80	101	158	160	156	160	174	104	93	35	32	111	138	162	234	185	161	113	37
29	2	30	30	40	64	68	104	95	162	91	120	70	74	40	30	84	102	135	195	145	130	90	38
34	2	22	30	31	63	90	130	125	135	125	148	108	85	31	30	90	109	145	193	143	129	92	32
41	6	20	26	31	70	85	130	130	135	125	152	95	75	31	26	100	90	155	208	150	132	98	27

PART 7.-WING OUTER PANEL (STATION 84) SKIN AND AIR TEMPERATURES. TABLE IV (CONTINUED)



LEGEND

M - STRUCTURE THERMOCOUPLE
A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE
SC - SURFACE THERMOCOUPLE

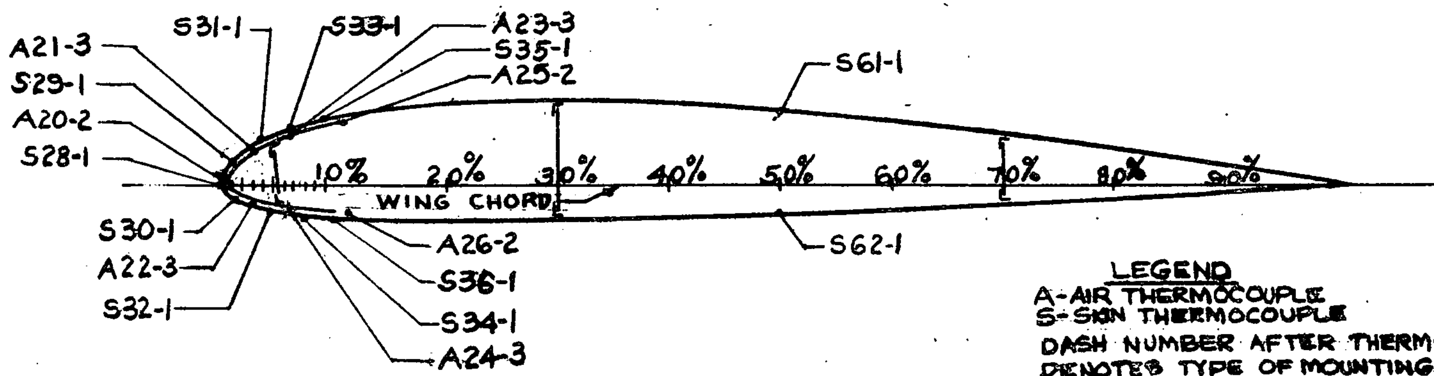
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

STATION 159

FLIGHT No.	RUN No.	AMBIENT AIR (°F)	TEMPERATURE (°F)																									
			S59	S57	S55	S26	S24	S22	S21	S19	S20	S23	S25	S27	S56	S58	S60	A19	A17	A15	A13	A14	A16	A18	A40	A39	M6	M5	M8
29	1	30	36	36	40	68	76	106	91	90	96	110	82	68	40	36	36	90	118	143	203	128	130	88	40	56	68	171	50
34	1	22	26	29	36	57	62	86	86	86	94	90	66	55	34	28	26	86	106	134	195	120	120	76	28	44	66	34	48
41	5	20	30	32	32	65	74	108	120	91	127	107	82	62	32	32	30	92	117	142	195	144	132	90	96	49	75	32	50
49	1	6	5	7	16	42	57	89	73	84	90	104	75	53	15	10	5	77	103	139	215	125	123	75	11	35	55	172	33
50	4	25	26	31	36	64	73	99	109	105	118	111	86	69	32	31	24	96	126	152	230	141	141	88	26	46	78	186	50
51	1	29	29	35	45	73	81	119	130	110	138	139	97	76	40	35	29	102	131	159	231	145	143	95	32	58	87	197	65
57	1	32	28	32	40	65	73	94	93	100	109	97	77	63	37	32	28	101	130	156	236	136	138	93	37	58	78	183	58
59	1	28	39	41	52	78	85	115	129	120	129	124	100	80	49	41	39	100	127	167	216	143	135	92	28	55	91	195	70
63	1	27	32	39	51	132	153	171	164	157	166	171	164	140	47	38	32	151	180	204	250	183	185	142	32	65	111	219	73
65	1	26	30	35	48	113	142	166	161	144	169	166	151	123	---	35	28	133	166	192	233	175	171	120	32	60	105	211	97
29	2	30	30	30	41	64	75	95	88	100	90	104	77	65	40	30	30	85	110	134	194	125	120	82	36	50	70	122	58
34	2	22	30	31	41	60	70	90	93	95	115	110	85	65	36	31	30	84	100	125	184	123	119	84	30	46	70	---	55
41	6	20	26	31	36	60	70	105	105	100	110	107	75	62	31	31	26	85	115	135	193	125	125	80	27	50	70	188	55

PART 8.-WING OUTER PANEL (STATION 159) SKIN, STRUCTURE & AIR TEMPERATURES. TABLE IV-(CONTINUED)

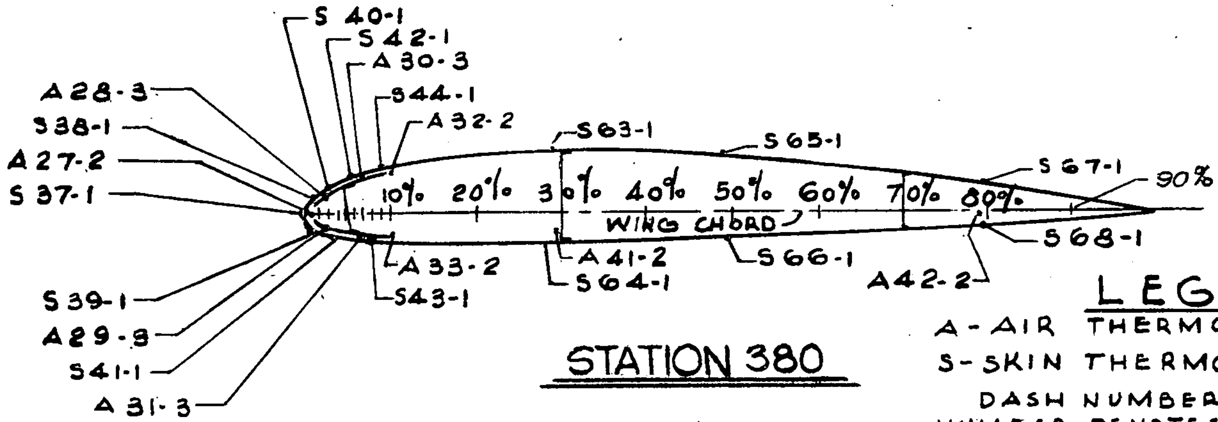


LEGEND
A-AIR THERMOCOUPLE
S-SKIN THERMOCOUPLE
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.
FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

STATION 290

FLIGHT No.	RUN No.	AMBIENT AIR (°F)	TEMPERATURE (°F)																	
			S61	S35	S33	S31	S29	S28	S30	S32	S34	S36	S62	A25	A23	A21	A20	A22	A24	A26
29	1	30	36	76	86	112	102	94	104	110	88	74	38	98	142	146	207	156	121	100
34	1	22	29	66	80	90	96	97	98	93	78	65	29	93	137	137	203	150	117	100
41	5	20	32	70	83	118	117	100	122	127	95	67	32	100	150	148	202	162	129	102
49	1	6	12	57	75	104	88	90	93	125	85	59	10	87	138	139	228	156	120	98
50	4	25	30	78	96	120	121	111	137	137	99	78	31	105	159	156	241	171	136	110
51	1	29	35	91	104	140	140	113	143	145	104	86	37	112	165	165	241	173	140	117
57	1	32	32	72	82	100	100	109	113	120	88	70	32	113	162	160	250	175	141	118
59	1	28	41	90	103	137	137	126	145	146	104	90	41	109	160	162	225	172	139	116
63	1	27	38	151	173	183	171	161	171	184	168	144	41	153	203	203	258	207	185	163
65	1	26	35	139	161	174	166	132	163	175	156	133	39	144	187	188	245	192	167	145
29	2	30	30	72	85	105	108	100	100	120	88	72	30	95	140	145	203	148	120	100
34	2	22	31	95	125	145	135	110	132	146	128	110	31	98	145	150	199	152	131	117
41	6	20	31	74	90	115	110	95	110	120	92	73	31	100	140	140	200	153	125	110

PART 9.-WING OUTER PANEL (STATION 290) SKIN AND AIR TEMPERATURES.
TABLE IV- (CONTINUED.



STATION 380

LEGEND

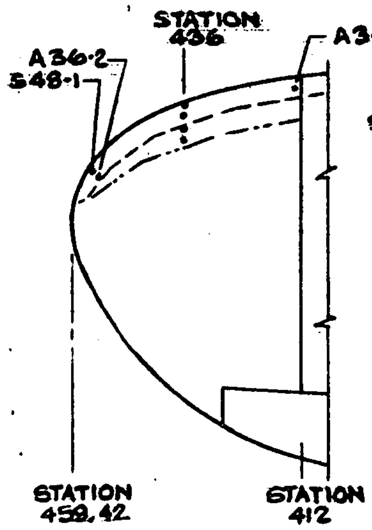
A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE

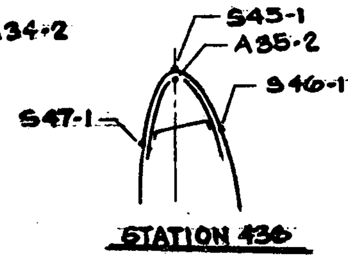
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)																						
			S67	S65	S63	S44	S42	S40	S38	S37	S39	S41	S43	S64	S66	S68	A32	A30	A28	A27	A29	A31	A33	A41	A42
29	1	30	35	40	40	74	80	116	118	88	115	106	82	42	38	35	106	140	166	212	168	122	118	64	40
34	1	22	26	29	37	64	75	110	126	82	111	105	75	39	29	26	90	134	155	214	155	115	160	55	28
41	5	20	30	32	30	67	80	128	147	87	150	124	72	32	32	30	107	142	167	216	167	127	117	59	26
49	1	6	7	11	21	57	75	128	150	105	150	135	80	22	11	7	109	151	183	245	183	133	132	53	11
50	4	25	27	31	38	76	90	145	167	96	167	150	96	40	31	27	115	152	184	255	185	132	135	67	27
51	1	29	29	35	48	83	95	153	170	96	164	159	97	48	35	29	122	159	188	254	187	137	140	71	32
57	1	32	26	28	36	60	69	111	128	90	135	122	80	39	30	24	128	156	180	263	185	143	145	74	35
59	1	28	39	42	53	90	103	156	165	115	166	149	104	55	41	39	120	160	185	238	186	140	138	75	28
63	1	27	35	41	53	140	160	193	195	151	192	185	135	56	40	35	151	197	218	268	216	175	171	87	32
65	1	26	32	37	50	112	138	176	185	162	176	167	118	53	34	32	136	182	203	247	197	155	156	78	32
29	2	30	30	30	45	65	80	108	128	85	115	110	80	45	30	30	97	140	160	208	155	127	120	62	36
34	2	22	30	31	41	92	115	148	156	107	148	145	124	41	31	30	110	148	164	203	160	138	133	63	30
41	6	20	26	31	41	65	80	122	140	80	140	128	82	41	31	26	110	135	160	208	164	128	125	62	27

PART 10.-WING OUTER PANEL (STATION 380) SKIN AND AIR TEMPERATURES. TABLE IV (CONTINUED)





LEGEND

A- AIR THERMOCOUPLE
S- SKIN THERMOCOUPLE

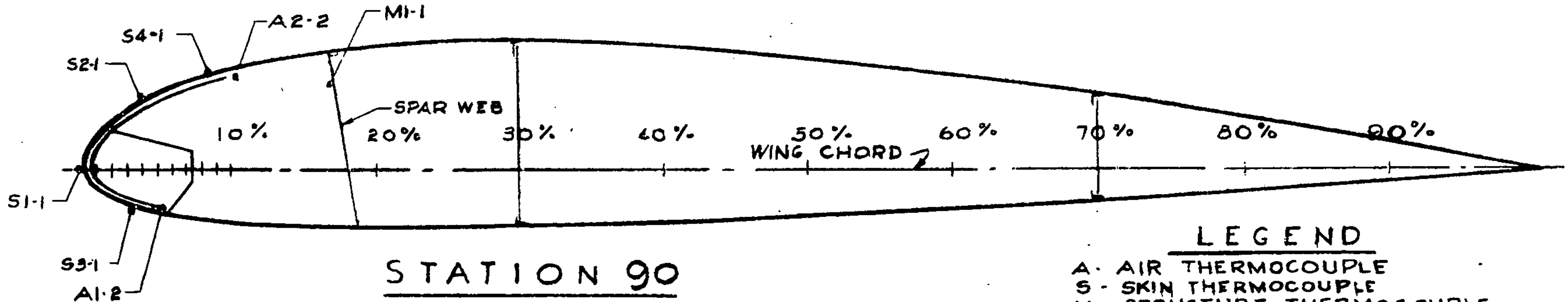
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS, SEE FIGURE 3.

WING TIP

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	TEMPERATURE (°F)						
			A34	S48	A36	S46	S45	S47	A35
29	1	30	194	52	173	140	56	140	188
34	1	22	192	44	172	100	53	96	181
41	5	20	197	51	175	142	50	132	190
49	1	6	215	63	192	137	65	130	208
50	4	25	224	54	198	150	59	140	214
51	1	29	227	55	200	158	61	152	216
57	1	32	227	42	208	138	51	122	220
59	1	28	215	60	192	157	75	150	207
68	1	27	245	78	220	166	87	163	238
65	1	26	227	55	203	170	64	166	220
29	2	30	183	48	164	130	55	128	175
34	2	22	183	65	165	118	60	115	175
41	6	20	188	45	170	120	55	120	180

PART II.-WING TIP SKIN & AIR TEMPERATURES.
TABLE IV (CONTINUED)



STATION 90

LEGEND

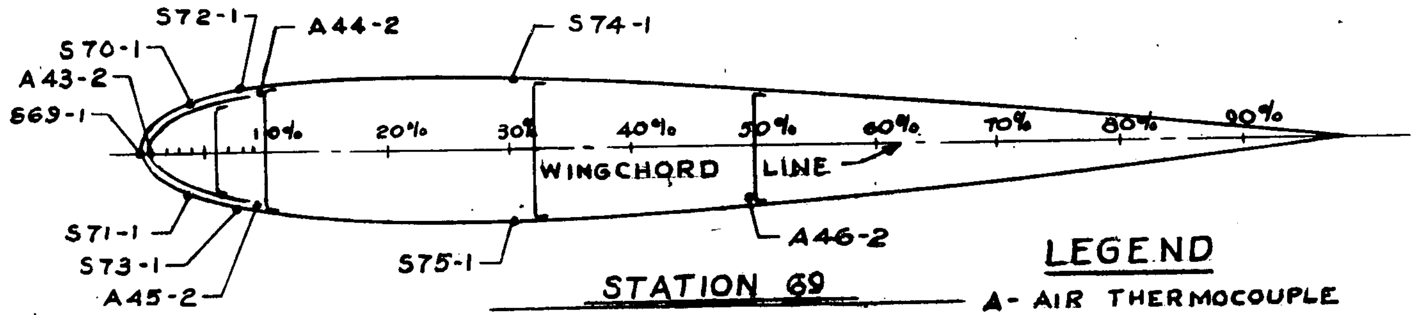
A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE
M - STRUCTURE THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)						
			S4	S2	S1	S3	A2	A1	M1
29	1	30	49	55	134	110	66	188	70
34	1	22	41	48	130	108	56	195	58
41	5	20	47	52	147	140	52	207	58
49	1	6	31	37	104	120	42	208	50
50	4	25	42	43	156	116	59	230	63
51	1	29	53	63	168	154	68	248	63
57	1	32	45	45	146	112	40	234	58
59	1	28	58	63	156	135	40	220	72
63	1	27	43	63	144	134	32	194	54
65	1	26	51	61	171	157	28	225	57
29	2	30	55	60	120	132	75	188	70
34	2	22	46	62	148	142	58	190	60
41	2	20	45	50	130	132	55	190	62

PART 12.- WING CENTER PANEL (STATION 90) SKIN AND AIR TEMPERATURES.
TABLE IV (CONTINUED)

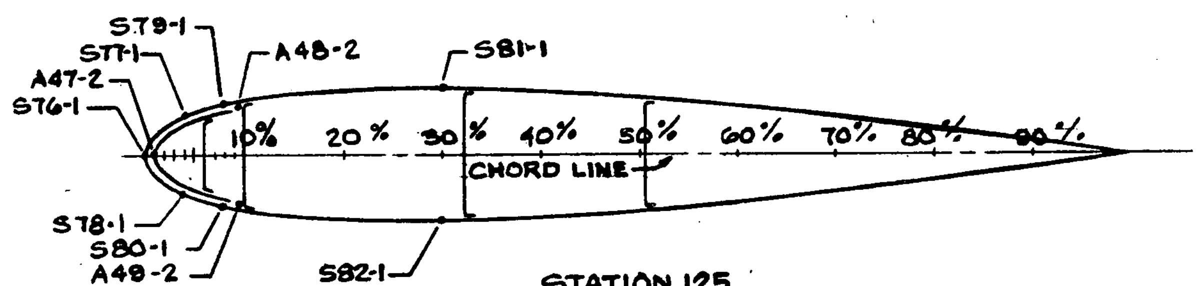


LEGEND

A- AIR THERMOCOUPLE
S- SKIN THERMOCOUPLE
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.
FOR MOUNTING TYPE DETAILS SEE FIG. 3.

FLIGHT No.	RUN No.	AMBIENT AIR (°F)	TEMPERATURE (°F)										
			S74	S72	S70	S69	S71	S73	S75	A44	A43	A45	A46
29	1	30	36	65	129	95	120	65	36	65	283	75	35
34	1	22	27	60	125	93	110	59	27	61	285	75	26
41	5	20	27	62	137	90	109	54	27	52	280	60	27
49	1	6	12	68	165	100	144	65	12	63	349	73	12
50	4	25	25	64	159	110	145	68	27	64	355	76	21
51	1	29	35	73	164	110	135	73	35	71	347	78	29
57	1	32	26	53	126	95	123	67	26	60	350	73	38
59	1	28	41	85	175	123	156	83	41	70	330	82	26
63	1	27	32	93	144	104	126	65	32	73	225	55	28
65	1	26	32	120	183	125	158	73	32	91	315	84	27
29	2	30	30	60	105	82	100	60	30	60	258	65	30
34	2	22	31	95	150	118	140	75	31	80	258	80	31
41	6	20	26	60	130	90	115	50	26	41	248	45	26

PART 13.- STABILIZER (STATION 69) SKIN & AIR TEMPERATURES. TABLE IV -(CONTINUED).



STATION 125

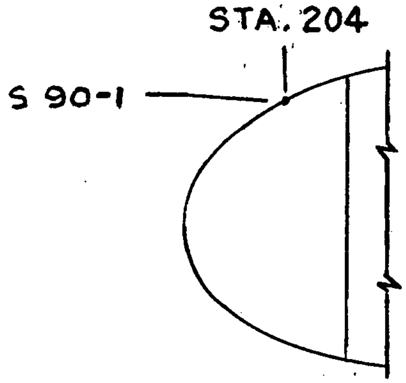
LEGEND

A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE

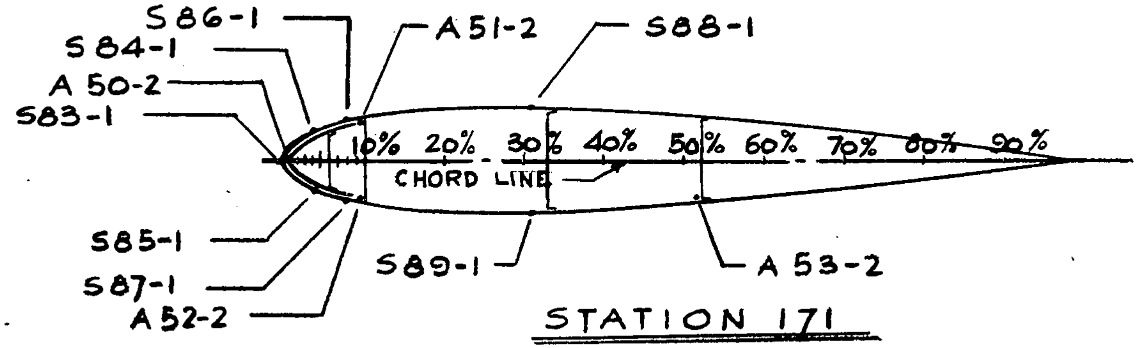
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.
FOR MOUNTING DETAILS, SEE FIGURE 3.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	TEMPERATURE (°F)									
			S81	S79	S77	S76	S78	S80	S82	A48	A47	A49
29	1	30	36	70	115	75	130	65	38	92	248	110
34	1	22	28	61	101	70	115	60	32	82	245	96
41	5	20	30	67	125	77	127	62	30	92	288	112
49	1	6	16	68	132	80	156	68	16	94	308	125
50	4	25	34	71	138	89	157	68	32	105	332	135
51	1	29	35	76	142	86	154	73	37	110	321	138
57	1	32	30	60	169	75	140	63	28	100	323	131
59	1	28	42	88	151	94	163	83	42	107	300	130
63	1	27	37	88	125	95	139	73	35	100	230	114
65	1	26	37	83	146	91	155	74	33	111	287	132
29	2	30	28	60	95	65	105	60	32	75	218	95
34	2	22	35	84	123	95	145	88	36	97	228	115
41	6	20	31	60	110	72	120	58	25	80	228	85

PART 14.-STABILIZER (STATION 125) SKIN & AIR TEMPERATURES.
TABLE IV (CONTINUED)



TIP



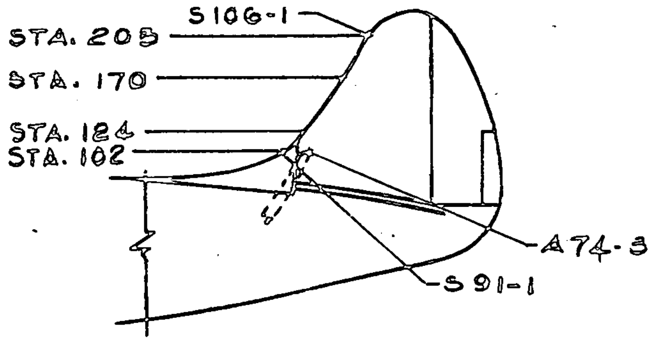
STATION 171

LEGEND

A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING. FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	TEMPERATURE (°F)											
			S90	S88	S86	S84	S83	S85	S87	S89	A51	A50	A52	A53
29	1	30	84	36	70	95	87	110	69	36	113	229	110	44
34	1	22	75	28	64	97	83	95	60	28	96	225	90	41
41	5	20	76	30	65	106	87	100	57	30	115	230	105	36
49	1	6	90	15	72	120	90	115	62	16	121	268	110	21
50	4	25	96	32	79	128	105	120	67	32	131	278	121	37
51	1	29	93	35	81	123	102	117	71	35	132	276	123	44
57	1	32	80	28	54	94	90	103	58	28	125	280	123	48
59	1	28	101	42	90	139	109	132	80	42	135	258	125	40
63	1	27	91	35	87	122	106	113	69	35	125	205	109	42
65	1	26	90	36	86	135	104	120	70	36	136	255	127	43
29	2	30	70	30	62	90	75	90	60	30	100	200	95	40
34	2	22	85	35	85	125	110	123	80	35	130	218	120	46
41	6	20	73	31	63	100	85	95	55	31	110	203	95	36

PART 15.–STABILIZER (TIP AND STATION 171) SKIN AND AIR TEMPERATURES.
TABLE IV (CONTINUED)



FIN

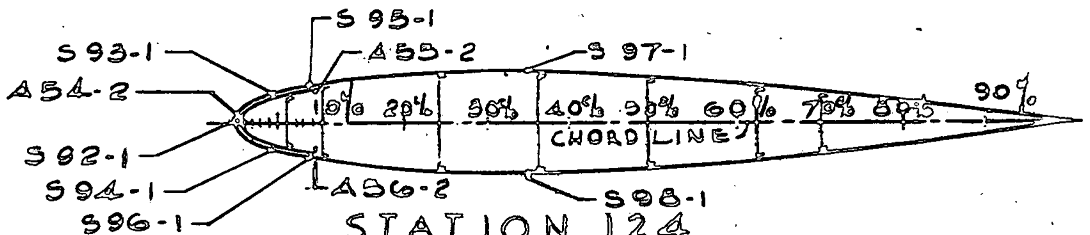
LEGEND

A- AIR THERMOCOUPLE

S- SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

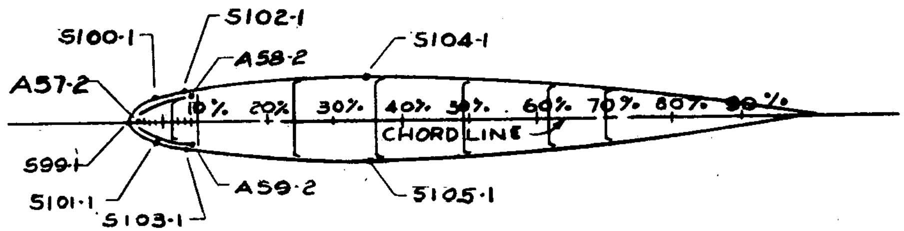
FOR MOUNTING TYPE DETAILS SEE FIGURE 3.



STATION 124

FLIGHT No	RUN No	AMBIENT AIR (°F)	TEMPERATURE (°F)												
			S91	S106	A74	S97	S95	S93	S92	S94	S96	S98	A55	A54	A56
29	1	30	31	99	330	40	102	157	98	140	92	40	142	312	128
34	1	22	28	90	321	36	92	148	106	128	85	36	140	295	125
41	5	20	21	100	335	30	92	158	118	140	82	30	145	315	137
49	1	6	10	137	401	18	93	169	160	153	88	18	147	372	120
50	4	25	22	115	410	32	106	179	143	169	100	32	162	382	136
51	1	29	26	116	413	40	112	189	132	171	106	40	173	390	148
57	1	32	22	107	419	32	104	173	110	155	99	32	165	398	134
59	1	28	35	125	387	43	114	183	165	171	112	43	160	360	136
63	1	27	32	112	292	35	86	137	151	127	65	35	127	235	104
65	1	26	35	135	367	40	109	177	168	162	101	37	159	347	134
29	2	30	27	85	297	45	94	138	90	125	65	45	130	278	115
34	2	22	26	120	300	31	90	145	158	133	85	31	133	280	117
41	6	20	21	90	312	31	90	140	125	130	85	30	130	288	110

PART 16.- FIN (DORSAL, TIP, AND STATION 124) SKIN AND AIR TEMPERATURES. TABLE IV (CONTINUED)



STATION 170

LEGEND

A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)									
			S104	S102	S100	S99	S101	S103	S105	A58	A57	A59
29	1	30	45	102	145	75	135	102	45	160	278	111
34	1	22	36	95	145	36	128	95	38	152	274	108
41	5	20	28	96	152	80	142	97	37	165	285	117
49	1	6	25	103	166	130	157	----	25	171	338	112
50	4	25	37	112	173	108	163	----	38	182	354	129
51	1	29	43	119	176	91	165	----	43	186	352	136
57	1	32	37	107	161	82	130	----	35	176	357	128
59	1	28	48	120	180	140	170	----	48	164	330	130
63	1	27	36	85	136	120	128	----	37	130	253	101
65	1	26	42	112	170	135	161	----	42	161	320	130
29	2	30	45	95	132	70	125	90	45	125	248	110
34	2	22	31	95	146	----	135	92	36	145	255	108
41	6	20	31	95	140	80	125	94	31	145	260	105

PART 17.-FIN (STATION 170) SKIN AND AIR TEMPERATURES.
TABLE IV (CONCLUDED)

DATE OF FLIGHT	FLIGHT №	RUN №	PRESSURE ALTITUDE (FT)	CORRECTED INDICATED AIRSPEED (MPH)	AMBIENT AIR (°F.)	① AIRPLANE OPERATING CONDITIONS	SEVERITY OF ICING	TYPE OF ICING
1-30-44	29	3	5,500	162	30	1900-RPM-CRUISE	MODERATE	GLAZE
2-7-44	34	3	4,620	159	21	1900-RPM-CRUISE	MODERATE	GLAZE & RIME
2-14-44	41	3	2,760	182	23	1900-RPM-CRUISE	LIGHT	GLAZE
3-1-44	50	5	5,500	153	26	1900-RPM-CRUISE	HEAVY	ROUGH GLAZE
3-2-44	51	2	5,200	164	28	1900-RPM-CRUISE	MODERATE	GLAZE
3-15-44	59	3	5,250	162	28	1900-RPM-CRUISE	LIGHT	GLAZE
3-17-44	60	4	3,450	163	17	1900-RPM-CRUISE	LIGHT	RIME
3-22-44	63	2	3,900	165	27	1900-RPM-CRUISE	LIGHT	GLAZE
3-24-44	65	2	4,050	170	27	1900-RPM-CRUISE	LIGHT	GLAZE

① SEE TABLE I.

PART I.- OPERATING CONDITIONS.

TABLE V

PERFORMANCE OF C-46 THERMAL ICE-PREVENTION SYSTEM DURING REDUCED-HEAT-FLOW TESTS IN NATURAL-ICING CONDITIONS.

FLIGHT NO.	RUN NO.	EXCHANGER HEAT FLOWS (1000 BTU/HR)			HEAT FLOWS TO HEATED SURFACES (1000 BTU/HR)			
		① LEFT OUTBOARD	② LEFT INBOARD	③ RIGHT INBOARD	LEFT WING OUTER PANEL	RIGHT STABILIZER	FIN	TO SECONDARY EXCHANGER
29	3	57	----	----	57	----	----	----
34	3	155	----	----	155	----	----	----
41	3	89	----	----	89	----	----	----
50	5	179	200	115	179	59	91	61
51	2	142	151	78	142	54	74	53
59	3	108	128	62	108	45	66	44
60	4	53	138	40	53	41	53	34
63	2	----	0	300	----	55	84	55
65	2	----	450	0	----	63	100	63

①-TEMPERATURE RISE USED TO CALCULATE HEAT TRANSFERRED = [(A_{62}) - (AMBIENT-AIR TEMPERATURE)] (°F).

②-TEMPERATURE RISE USED TO CALCULATE HEAT TRANSFERRED = [(A_{56}) - (AMBIENT-AIR TEMPERATURE)] (°F).

③-PORTION OF RIGHT INBOARD HEAT-EXCHANGER HEAT FLOW MEASURED AT VENTURI NO.3.

PART 2.- HEAT DISTRIBUTION.

TABLE V (CONTINUED).

FLIGHT NO.	RUN NO.	AVERAGE HEAT DELIVERED PER SQUARE FT. OF DOUBLE-SKIN LEADING EDGE SURFACE (BTU/HR)			AVERAGE HEAT FLOW THRU HEATED SKIN SURFACE PER SQUARE FT. OF DOUBLE SKIN SURFACE (BTU/HR)			RATIO OF HEAT FLOW THRU HEATED SKIN SURFACE TO HEAT DELIVERED			AVERAGE TEMP. RISE OF WING
		LEFT WING OUTER PAN.	RIGHT STABILIZER	VERTICAL FIN.	① LEFT WING OUTER PAN.	② RIGHT STABILIZER	③ VERT. FIN	LEFT WING OUTER PAN.	RIGHT STABILIZER	VERTICAL FIN.	OUTER PANEL % CHORD (°F)
29	3	540	----	----	250	----	----	0.48	----	----	39.5
34	3	1460	----	----	760	----	----	.52	----	----	56.5
41	3	840	----	----	440	----	----	.52	----	----	47.5
50	5	1,690	2,760	5,050	830	1,230	2,880	.49	0.45	0.57	61.5
51	2	1,340	2,500	4,110	640	970	2,300	.47	.39	.56	63.0
59	3	1,020	2,110	3,660	470	840	1,970	.46	.40	.54	71.0
60	4	490	1,890	2,930	240	700	1,650	.48	.37	.56	94.0
63	2	----	2,560	4,680	----	1,130	2,560	----	.44	.55	----
65	2	----	2,940	5,560	----	1,370	2,920	----	.47	.52	----

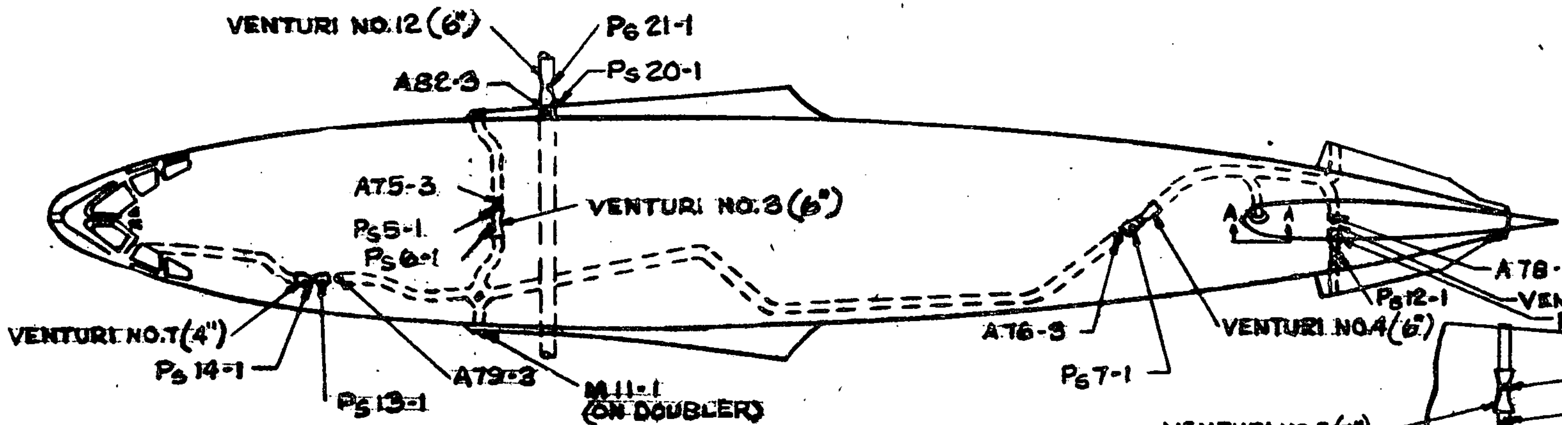
① CALCULATED ON BASIS OF AVERAGE TEMPERATURE DROP OF THE HEATED AIR IN THE CORRUGATIONS AT STATIONS 24, 84, 159, 290 AND 380 AND THE TOTAL AIRFLOW RATE FROM LEFT OUTBOARD EXCHANGER.

② CALCULATED ON BASIS OF AVERAGE TEMPERATURE DROP OF THE HEATED AIR IN THE CORRUGATIONS AT STATIONS 69, 125, AND 171, AND THE TOTAL AIRFLOW RATE TO THE RIGHT STABILIZER.

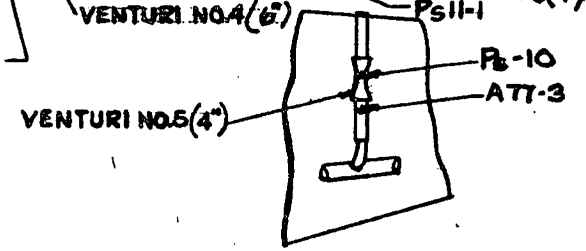
③ CALCULATED ON BASIS OF AVERAGE TEMPERATURE DROP OF THE HEATED AIR IN THE CORRUGATIONS AT STATIONS 124 AND 170 AND THE TOTAL AIRFLOW RATE TO THE VERTICAL FIN.

PART 3.— SURFACE HEATING VALUES.

TABLE V (CONTINUED)



PLAN OF FUSELAGE



VIEW "A-A"
SHOWING DUCT TO FIN

LEGEND

A - AIR THERMOCOUPLE
P_S - PRESSURE ORIFICE (STATIC)
M - STRUCTURE THERMOCOUPLE

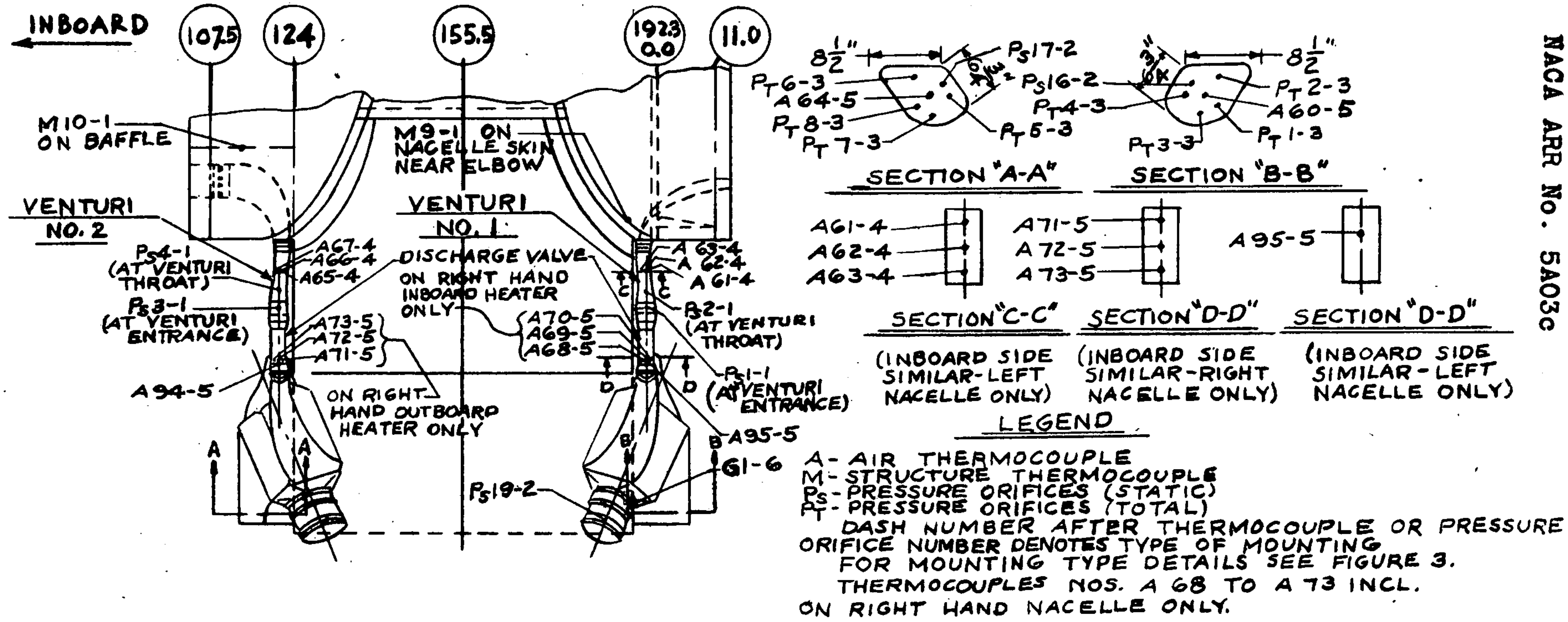
DASH NUMBER AFTER THERMOCOUPLE OR PRESSURE ORIFICE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS, SEE FIGURE 3.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	VENTURI FLOW RATES (LB/HR)						TEMPERATURE (°F)						
			NO.3	NO.4	NO.5	NO.6	NO.7	NO.12	A75	A76	A77	A78	A79	A82	M11
50	5	26	1,200	2,490	1,158	741	781.5	0	416	360	350	354	345	250	142
51	2	28	845	2,110	937	672	674	0	406	362	351	356	349	245	126
59	3	28	579	2,025	885	616	611	0	462	349	333	330	324	194	116
60	4	17	401	2,025	839	646	565	0	415	290	276	276	265	176	70
63	2	27	3,318	2,685	1,220	830	756	0	400	320	310	310	325	190	93
65	2	27	0	3,300	1,502	932	910	0	---	308	301	305	313	215	120

PART 4.- FUSELAGE AIR TEMPERATURES, AIR-FLOW RATES, & DOUBLER TEMPERATURES.

TABLE V (CONTINUED)

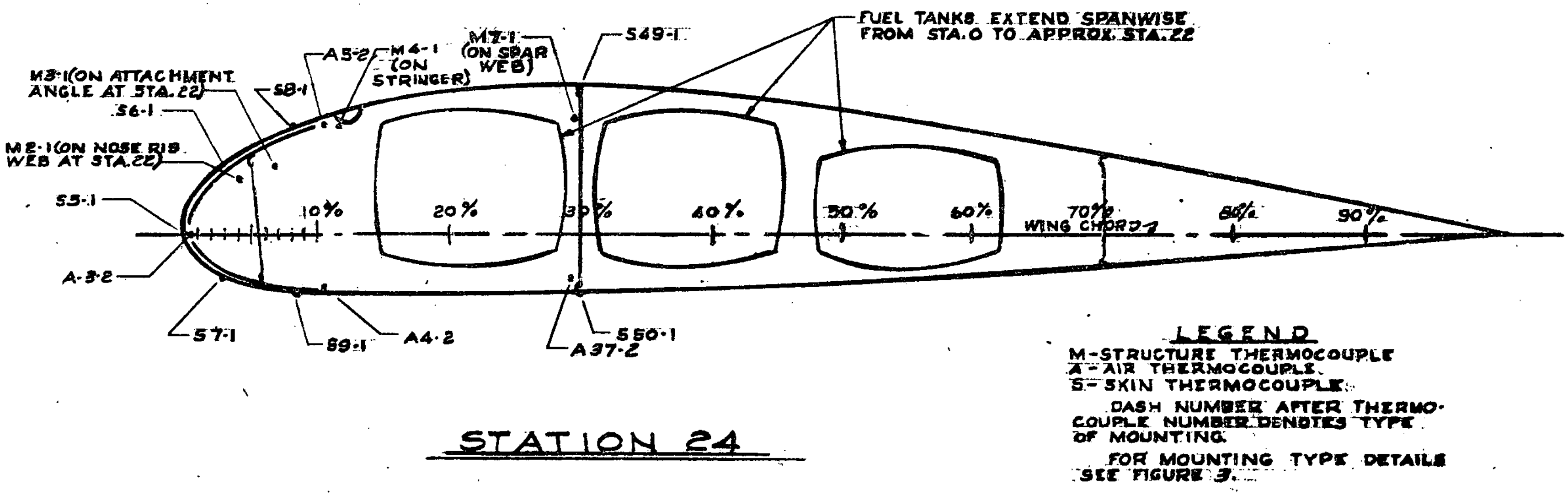


FLIGHT NO	RUN NO.	AMBIENT AIR (°F)	VENTURI FLOW RATES (LB/HR)		TEMPERATURE (°F)															
			① NO. 1	② NO. 2	A61	A62	A63	A95	A65	A66	A67	A94	M10	M9	A68	A69	A70	A71	A72	A73
29	3	30	880	-----	312	295	40	374	---	---	---	---	---	79	---	---	---	---	---	---
34	3	21	2,725	-----	276	256	---	302	---	---	---	---	---	74	---	---	---	---	---	---
41	3	23	1,717	-----	268	238	---	309	---	---	---	---	---	70	---	---	---	---	---	---
50	5	26	2,500	2,565	348	320	302	355	---	346	340	394	213	90	410	230	511	292	315	340
51	2	28	2,092	1,907	336	308	293	351	---	354	353	402	213	89	429	445	541	284	305	326
59	3	28	1,710	1,730	315	288	275	147	---	332	340	379	215	98	468	464	546	399	446	450
60	4	17	843	1,557	303	275	263	351	---	372	273	338	169	73	472	478	543	374	413	442
63	2	27	-----	0	---	---	---	---	---	265	276	448	185	92	302	320	394	---	---	---
65	2	27	-----	5,980	---	---	---	---	---	337	298	344	197	89	568	578	697	---	---	---

① FLOW RATE CALCULATION BASED ON TEMPERATURE A62 AT VENTURI Nº 1.
② " RATE CALCULATION BASED ON TEMPERATURE A66 AT VENTURI Nº 2.

PART 5.- HEAT-EXCHANGER AIR TEMPERATURES & FLOW RATES

TABLE V (CONTINUED)

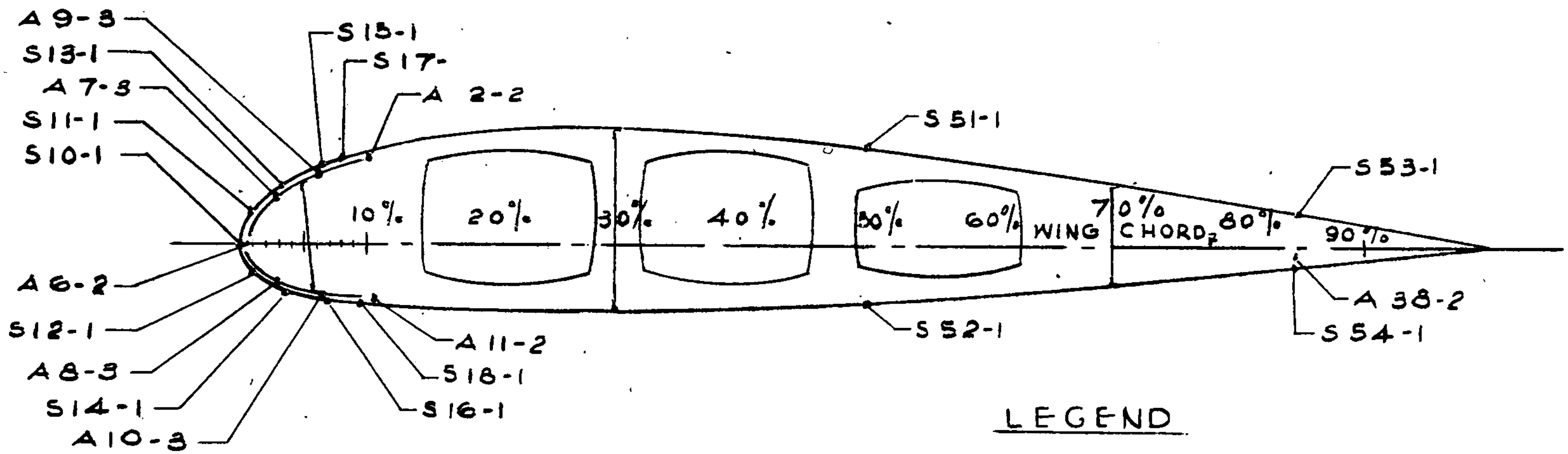


STATION 24

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)														
			S49	S8	S6	S5	S7	S9	S50	A5	A3	A4	A37	M2	M3	M4	M7
29	3	30	40	54	70	80	65	55	40	73	203	64	45	170	132	55	50
34	3	21	34	53	68	91	68	56	42	74	193	63	44	175	134	58	48
41	3	23	34	51	80	98	77	54	34	70	183	65	40	154	108	51	39
50	5	26	36	58	70	103	93	55	30	83	227	68	36	197	160	60	45
51	2	28	40	66	86	108	91	70	29	88	227	76	40	200	157	61	51
59	3	28	53	73	104	123	107	80	45	90	204	83	51	212	229	75	60
60	4	17	33	55	89	135	105	68	24	80	205	78	40	191	144	61	42

PART 6.- WING OUTER PANEL (STATION 24) SKIN, STRUCTURE, AND AIR TEMPERATURES.

TABLE V (CONTINUED)



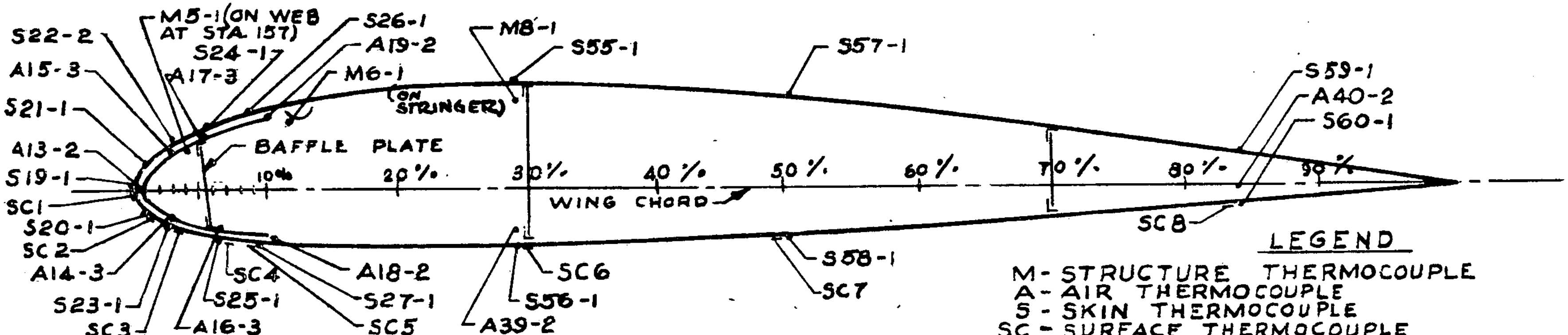
STATION 84

LEGEND

A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE
DASH NUMBER AFTER THERMOCOUPLE DENOTES TYPE OF MOUNTING.
FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)																				
			S53	S51	S17	S15	S13	S11	S10	S12	S14	S16	S18	S52	S54	A12	A9	A7	A6	A8	A10	A11	A38
29	3	30	36	36	45	55	90	65	85	70	110	57	50	36	36	60	70	125	193	105	85	60	31
34	3	21	26	28	44	55	88	78	88	78	98	55	48	28	26	61	75	118	188	105	93	61	26
41	3	23	30	30	44	52	95	84	95	89	110	53	50	30	30	56	61	119	182	102	90	58	24
50	5	26	25	25	50	60	90	70	88	85	104	58	51	25	25	65	80	127	218	125	100	68	26
51	2	28	28	28	56	66	107	106	96	103	126	66	57	28	28	76	93	143	218	133	114	80	26
59	3	28	42	42	85	103	146	135	110	125	157	98	78	42	42	87	112	154	210	130	112	88	36
60	4	17	20	21	51	67	116	112	128	112	145	77	59	21	17	70	93	142	208	139	120	52	21

PART 7.- WING OUTER PANEL (STATION 84) SKIN AND AIR TEMPERATURES. TABLE V (CONTINUED)



STATION 159

LEGEND

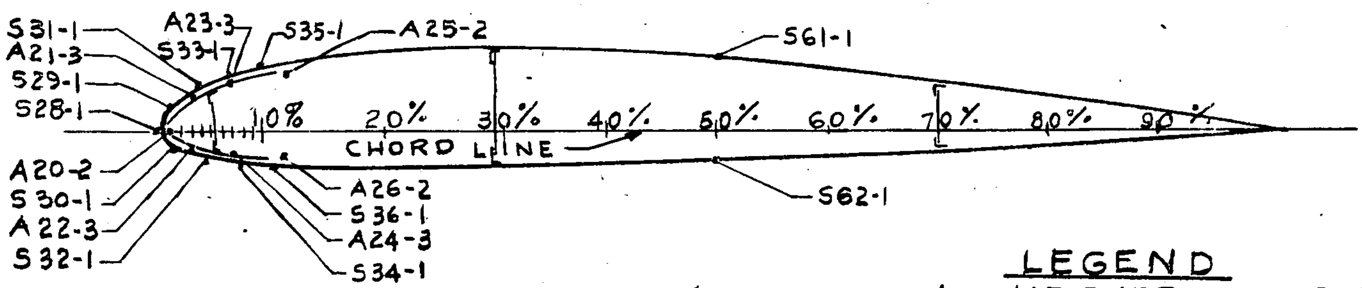
M - STRUCTURE THERMOCOUPLE
A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE
SC - SURFACE THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)																										
			S59	S57	S55	S26	S24	S22	S21	S19	S20	S23	S25	S27	S56	S58	S60	A19	A17	A15	A13	A14	A16	A18	A40	A39	M6	M5	M8
29	3	30	36	36	36	43	50	75	63	62	72	75	55	44	36	36	36	60	73	105	180	85	83	53	31	36	42	132	38
34	3	21	26	26	31	44	53	75	63	72	78	74	55	40	28	26	26	61	81	107	178	93	94	54	27	34	48	--	36
41	3	23	31	30	30	40	45	70	60	55	71	68	48	41	30	30	30	50	71	94	164	77	74	48	24	34	34	--	33
50	5	26	25	25	32	50	55	78	78	86	92	85	65	46	30	25	25	65	90	123	205	104	103	60	25	37	56	156	40
51	2	28	28	28	35	51	60	94	91	91	97	107	76	56	36	28	28	73	95	128	206	114	114	75	26	43	56	158	45
59	3	28	42	42	48	72	82	115	106	93	114	120	90	77	48	42	42	74	98	135	195	110	107	70	36	49	69	166	53
60	4	17	20	21	20	74	90	124	109	113	111	124	102	81	27	21	20	85	118	144	196	125	127	82	21	34	56	160	36

PART 8.-WING OUTER PANEL (STATION 159) SKIN, STRUCTURE, & AIR TEMPERATURES. TABLE V - (CONTINUED)



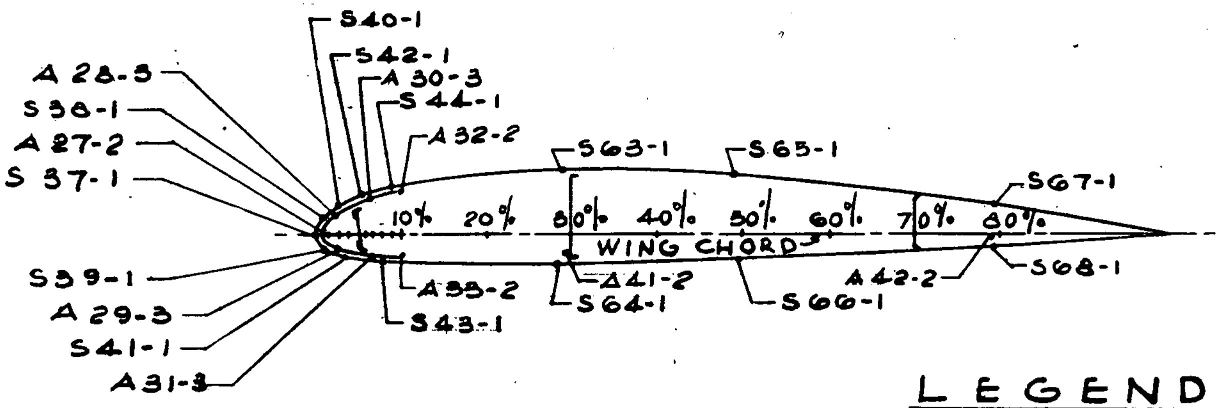
STATION 290

LEGEND

A — AIR THERMOCOUPLE
S — SKIN THERMOCOUPLE
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.
FOR MOUNTING DETAILS SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)																	
			S61	S35	S33	S31	S29	S28	S30	S32	S34	S36	S62	A25	A23	A21	A20	A22	A24	A26
29	3	30	36	44	50	70	65	62	63	65	45	43	36	55	70	80	164	90	64	53
34	3	21	26	45	56	77	72	73	73	82	56	44	26	54	91	96	176	111	81	61
41	3	23	30	32	45	56	59	54	54	60	38	30	30	53	58	71	136	74	49	44
50	5	26	25	53	60	80	83	87	85	93	65	53	25	63	103	110	205	127	90	68
51	2	28	28	51	71	96	96	86	91	93	66	50	28	73	104	110	203	125	93	73
59	3	28	42	68	79	103	99	90	93	104	79	68	42	70	100	110	190	120	91	73
60	4	17	20	73	91	109	102	98	99	104	83	64	18	77	105	115	183	125	92	69

PART 9.-WING OUTER PANEL(STATION 290)SKIN AND AIR TEMPERATURES.
TABLE V-(CONTINUED.)



STATION 380

LEGEND

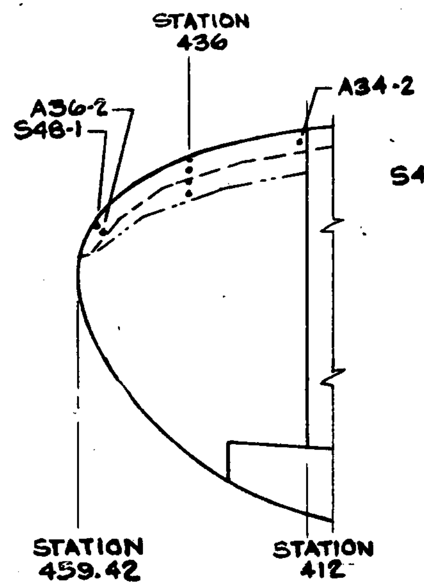
A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE

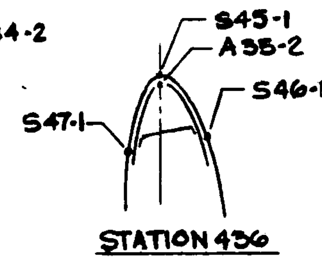
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT №	RUN №	AMBIENT AIR (°F)	TEMPERATURE (°F)																							
			S67	S65	S63	S44	S42	S40	S38	S37	S39	S41	S43	S64	S66	S68	A32	A30	A28	A27	A29	A31	A33	A41	A42
29	3	30	36	36	36	40	50	68	80	58	70	65	40	36	36	36	52	80	110	193	105	65	68	36	31
34	3	21	25	26	31	44	53	82	98	64	88	78	52	32	26	26	73	98	123	196	123	83	84	39	24
41	3	23	20	30	30	34	40	60	79	50	61	44	34	30	30	22	36	60	81	156	78	51	50	28	20
50	5	26	25	25	25	48	60	95	105	73	105	92	60	30	25	25	83	112	142	230	142	98	97	48	26
51	2	28	28	28	35	51	69	107	127	73	117	96	56	35	28	28	91	112	140	227	140	93	96	53	26
59	3	28	42	42	45	67	78	113	116	80	114	100	74	45	42	42	80	109	130	209	128	90	90	50	36
60	4	17	21	20	26	50	72	104	118	88	109	93	58	24	20	19	64	105	134	202	129	78	80	34	21

PART 10.- WING OUTER PANEL (STATION 380) SKIN AND AIR TEMPERATURES. TABLE V (CONTINUED)





WING TIP

LEGEND

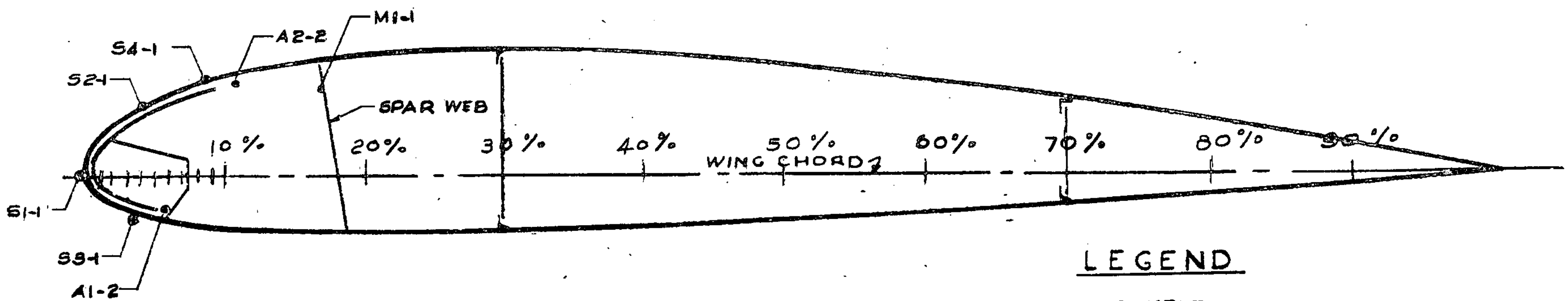
A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING DETAILS SEE FIGURE 3.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	TEMPERATURE (°F)						
			A34	S48	A36	S46	S45	S47	A35
29	3	30	157	40	124	65	41	64	134
34	3	21	166	34	138	97	40	94	149
41	3	23	100	30	56	45	30	48	80
50	5	26	192	40	158	102	48	95	170
51	2	28	188	41	157	159	43	---	169
59	3	28	172	---	144	99	55	99	150
60	4	17	160	28	118	62	35	62	130

PART II.-WING TIP SKIN & AIR TEMPERATURES,
TABLE V (CONTINUED)



STATION 90

LEGEND

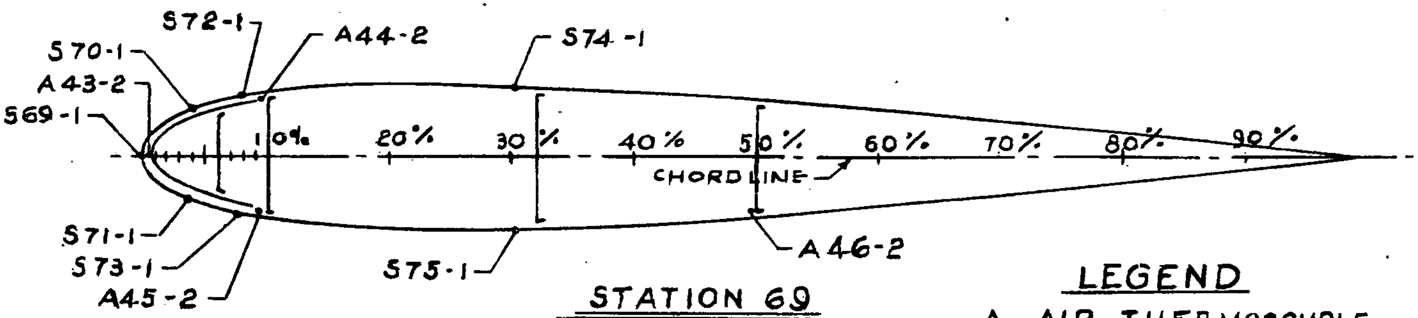
A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE
M - STRUCTURE THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	TEMPERATURE (°F)						
			S4	S2	S1	S3	A2	A1	M1
50	5	26	38	38	117	90	48	182	60
51	2	28	35	42	117	102	45	187	56
59	3	28	54	60	134	130	52	189	68
60	4	17	33	48	122	99	32	162	43
63	2	27	48	68	104	125	32	170	60
65	2	27	45	55	143	135	32	193	60

PART 12.-WING CENTER PANEL (STATION 90) SKIN AND AIR TEMPERATURES.
TABLE V (CONTINUED)



STATION 69

LEGEND

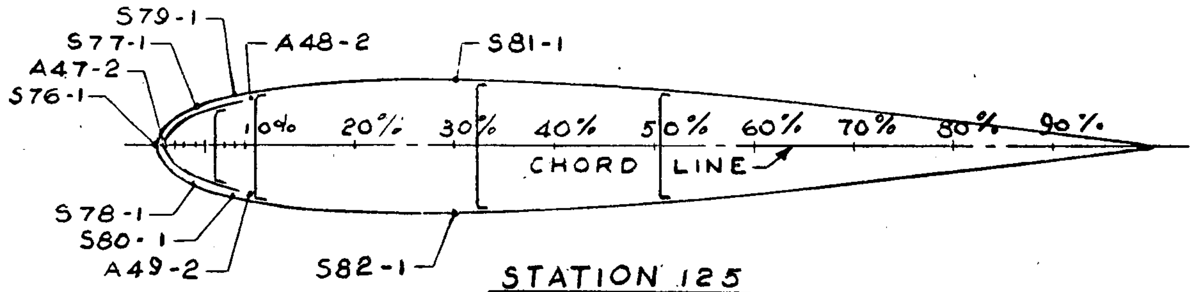
A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING DETAILS SEE FIGURE 3.

FLIGHT Nº	RUN Nº	AMBIENT AIR (°F)	TEMPERATURE (°F)										
			S74	S72	S70	S69	S71	S73	S75	A44	A43	A45	A46
50	5	26	25	41	105	62	90	48	30	40	210	40	25
51	2	28	24	46	96	51	79	46	24	43	173	45	24
59	3	28	42	59	104	160	90	54	42	48	165	52	33
60	4	17	21	62	101	57	84	37	21	40	134	35	21
63	2	27	90	80	130	78	104	55	30	53	197	45	32
65	2	27	32	63	121	83	99	58	30	58	224	53	30

PART 13.– STABILIZER (STATION 69) SKIN & AIR TEMPERATURES.
TABLE V - (CONTINUED)



STATION 125

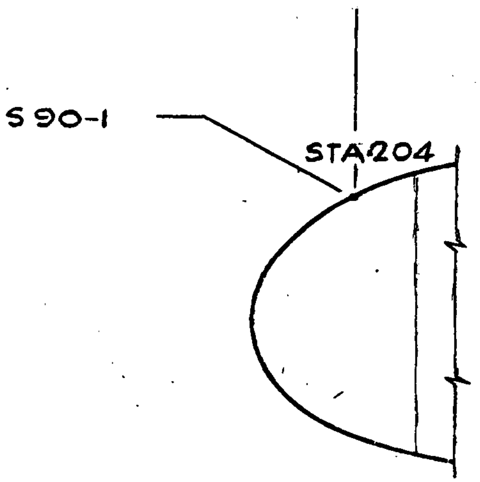
LEGEND

A- AIR THERMOCOUPLE
S- SKIN THERMOCOUPLE

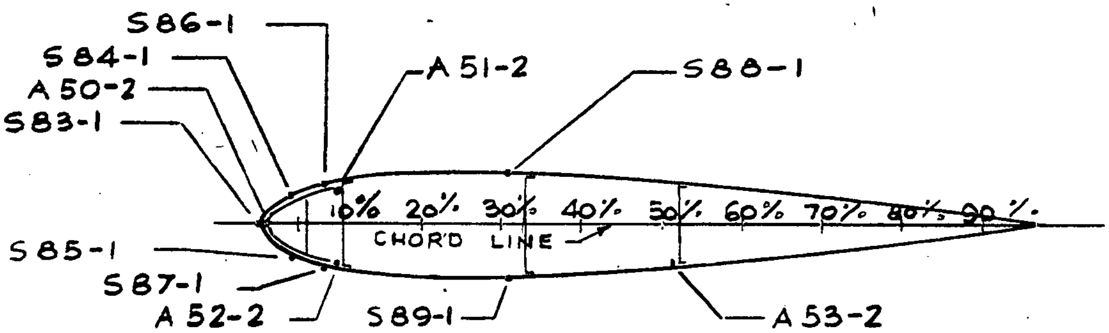
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING, FOR MOUNTING DETAILS SEE FIGURE 3.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	TEMPERATURE (°F)									
			S81	S79	S77	S76	S78	S80	S82	A48	A47	A49
50	5	26	30	53	100	68	115	53	30	75	240	95
51	2	28	29	56	93	66	112	56	25	75	227	89
59	3	28	48	64	99	145	113	62	45	73	220	89
60	4	17	25	64	93	73	108	53	21	75	190	85
63	2	27	35	78	115	85	133	65	32	95	224	109
65	2	27	37	53	104	75	113	62	32	88	226	104

PART 14.-STABILIZER (STATION 125) SKIN & AIR TEMPERATURES
TABLE V (CONTINUED)



TIP



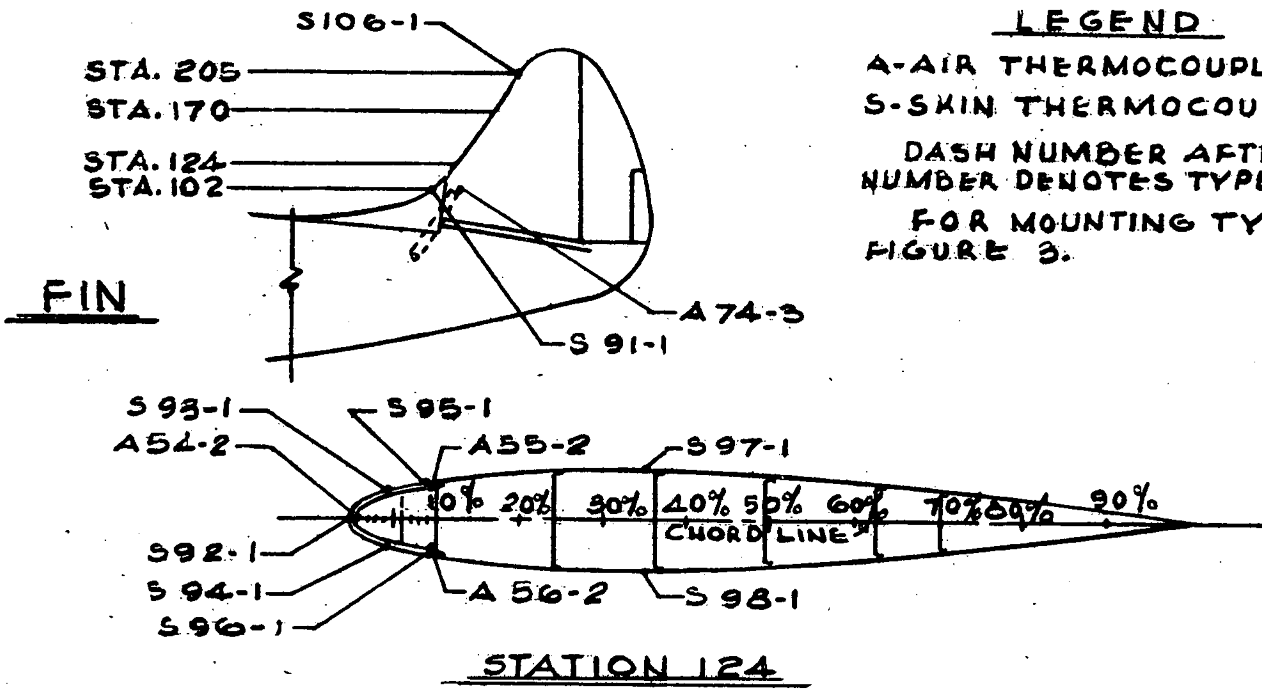
STATION 171

LEGEND

A—AIR THERMOCOUPLE
S—SKIN THERMOCOUPLE
DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.
FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT NO.	RUN NO.	AMBIENT AIR (°F)	TEMPERATURE (°F)											
			S90	S88	S86	S84	S83	S85	S87	S89	A51	A50	A52	A53
50	5	26	70	28	60	90	80	93	53	28	99	212	93	33
51	2	28	66	29	57	85	79	86	56	29	95	206	91	32
59	3	28	77	48	72	93	85	91	63	48	93	197	88	39
60	4	17	68	26	67	93	81	88	51	25	95	170	88	30
63	2	27	80	35	83	118	99	110	63	35	122	205	109	42
65	2	27	78	39	62	93	83	92	58	37	104	196	95	42

PART 15.— STABILIZER (TIP AND STATION 171) SKIN AND AIR TEMPERATURES.
TABLE V (CONTINUED)



LEGEND

A-AIR THERMOCOUPLE

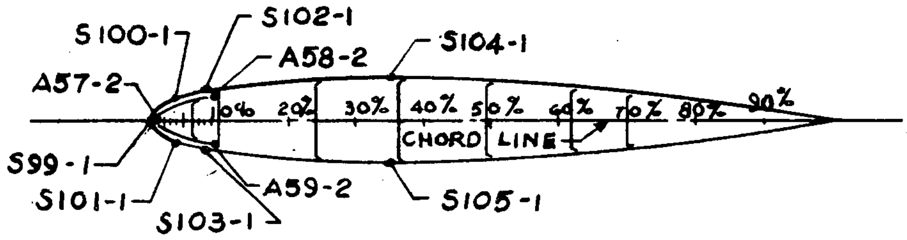
S-SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT No	RUN No	AMBIENT AIR (°F)	TEMPERATURE (°F)												
			S91	S106	A74	S97	S95	S93	S92	S94	S96	S98	A55	A54	A56
50	5	26	25	85	333	32	73	125	95	114	72	32	115	305	95
51	2	28	23	81	331	32	67	115	91	105	67	32	107	295	85
59	3	28	40	90	312	48	81	125	94	114	79	48	111	282	88
60	4	17	20	83	258	27	55	94	104	85	53	27	87	234	64
63	2	27	32	100	296	40	80	130	133	118	78	40	120	273	98
65	2	27	32	104	292	38	88	138	132	125	83	38	127	270	104

PART 16.- FIN (DORSAL, TIP AND STATION 124) SKIN AND AIR TEMPERATURES. TABLE V (CONTINUED)



STATION 170

LEGEND

A - AIR THERMOCOUPLE
S - SKIN THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING. FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

FLIGHT №	RUN №	AMBIENT AIR (°F)	TEMPERATURE (°F)									
			S104	S102	S100	S99	S101	S103	S105	A58	A57	A59
50	5	26	32	80	114	73	113	32	32	125	275	88
51	2	28	32	70	112	72	102	29	32	112	258	76
59	3	28	48	81	118	75	109	48	48	104	249	80
60	4	17	27	56	90	85	85	34	27	84	205	61
63	2	27	40	80	127	105	120	32	40	122	248	90
65	2	27	37	88	133	102	125	32	39	125	247	103

PART 17. - FIN (STATION 170) SKIN & AIR TEMPERATURES.
TABLE V - (CONCLUDED)

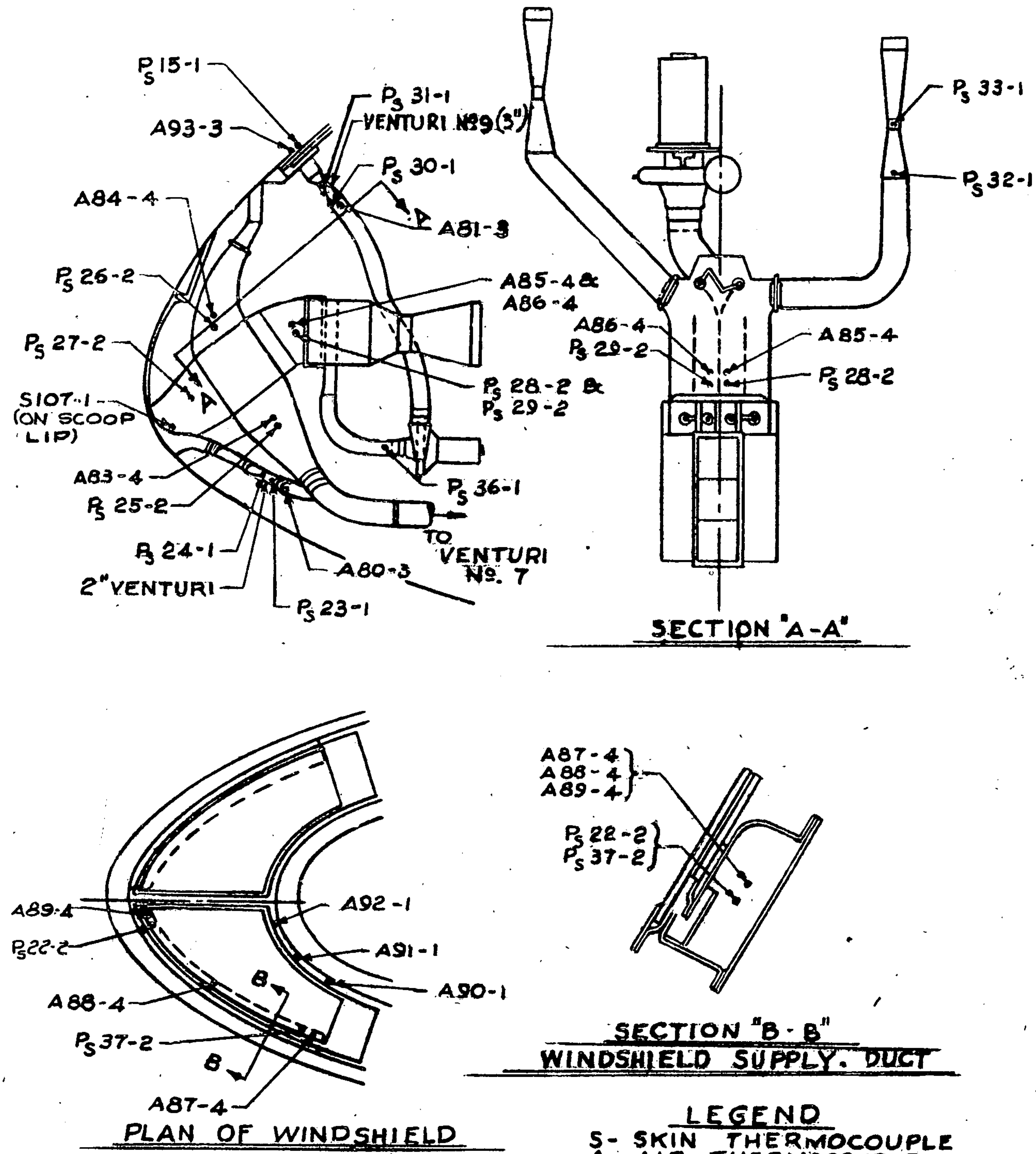
FLIGHT NUMBER	61	64	64	65
RUN NUMBER	4	1	2	3
PRESSURE ALTITUDE (FT)	18,000	5,300	5,000	4.500
CORRECTED INDICATED AIRSPEED (MPH)	143	165	164	159
AIRPLANE OPERATING CONDITIONS	1900 R.P.M. CRUISE			
METEROLOGICAL CONDITIONS	DRY AIR	LIGHT ICE	LIGHT ICE	LIGHT ICE
AMBIENT AIR TEMPERATURES (°F)	-12	21	21	29
PRIMARY AIR FLOW AT VENTURI №7 (LB/HR)	725	716	1,088	1,049
A83 (°F)	383	271	328	336
A84 (°F)	233	153	196	218
HEAT TRANSFERRED FROM PRIMARY AIR (BTU/HR)	26,400	20,400	34,700	30,000
SECONDARY AIR FLOW, VENTURI №9 (LB/HR)	386	650	604	589
S107 (°F)	38	48	54	63
A85 (°F)	210	126	165	187
A86 (°F)	214	130	166	187
A81 (°F)	202	132	170	191
HEAT DELIVERED TO WINDSHIELDS (BTU/HR) REFERRED TO AMBIENT AIR	19,900	17,400	21,600	22,900
A93 (°F)	151	119	146	164
A87 (°F)	127	115	130	148
A88 (°F)	180	129	153	182
A89 (°F)	196	130	158	187
A90 (°F)	85	94	105	109
A91 (°F)	100	101	118	113
A92 (°F)	93	93	111	120

NOTE: SKETCH ON FOLLOWING PAGE

PART I.- TEMPERATURES AND HEATED-AIR-FLOW-RATES

TABLE VI

PERFORMANCE OF SECONDARY HEAT-EXCHANGER AND WINDSHIELD THERMAL ICE-PREVENTION SYSTEM

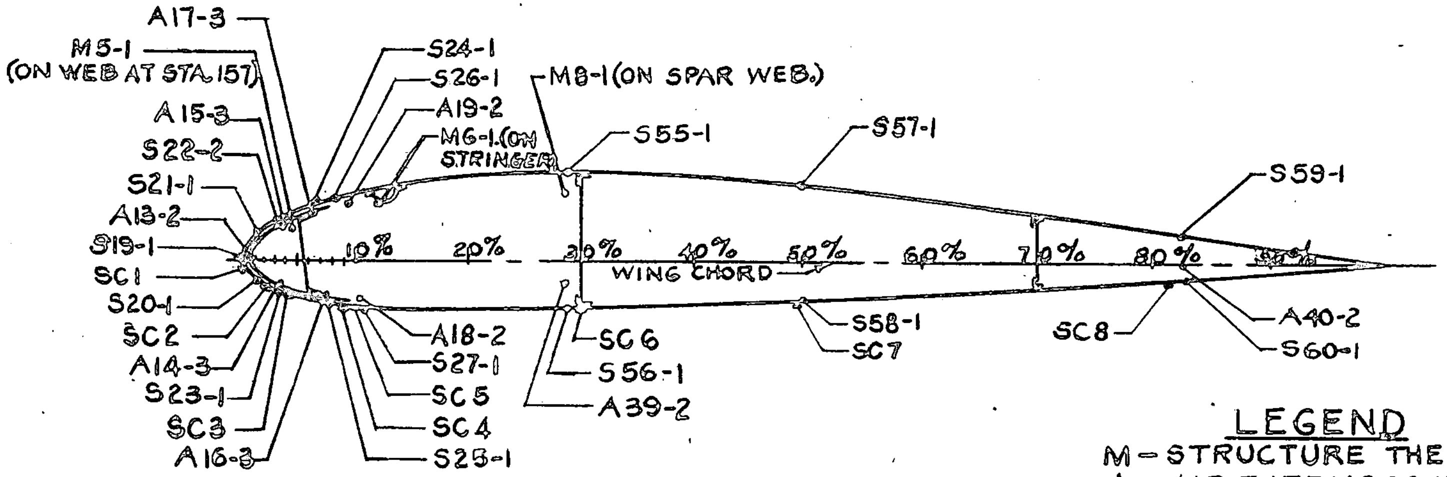


LEGEND

S- SKIN THERMOCOUPLE
A- AIR THERMOCOUPLE
P_S- PRESSURE ORIFICE (STATIC)

DASH NUMBER AFTER THERMOCOUPLE OR PRESSURE ORIFICE NUMBER DENOTES TYPE OF MOUNTING.
FOR MOUNTING TYPE DETAILS SEE FIGURE 3.

PART 2.- INSTRUMENTATION
TABLE VI - (CONCLUDED)



STATION 159

LEGEND

M – STRUCTURE THERMOCOUPLE
A – AIR THERMOCOUPLE
S – SKIN THERMOCOUPLE
SC – SURFACE THERMOCOUPLE

DASH NUMBER AFTER THERMOCOUPLE NUMBER DENOTES TYPE OF MOUNTING.

FOR MOUNTING TYPE DETAILS SEE FIG.3

FLIGHT No.	METEOROLOGICAL CONDITIONS.	PRESSURE ALTITUDE (FT)	AMBIENT AIR TEMP (°F)	TEMPERATURES INDICATED (°F)							
				S19	SC1	S20	SC2	S23	SC3	S25	SC4
65	LIGHT ICE	4,000	26	150	126	158	125.5	164.5	141.5	145	140
51	LIGHT ICE	5,350	29	135	110	126	93	128.5	103	102	87
60	LIGHT ICE	3,600	16	114	96	116	97	124.5	112	108	109
60	DRY AIR	10,400	11	144	120	147.5	121	157.1	137	141.8	139
64	DRY AIR	7,000	18	161	137	162	131.5	166	147	150	147

TABLE VII.

COMPARISON OF TYPICAL SURFACE THERMOCOUPLE AND WASHER THERMOCOUPLE. DATA TAKEN AT STATION 159 FOR 1900-RPM CRUISE OPERATION OF THE AIRPLANE AND FULL-HEATED-AIRFLOW RATES.

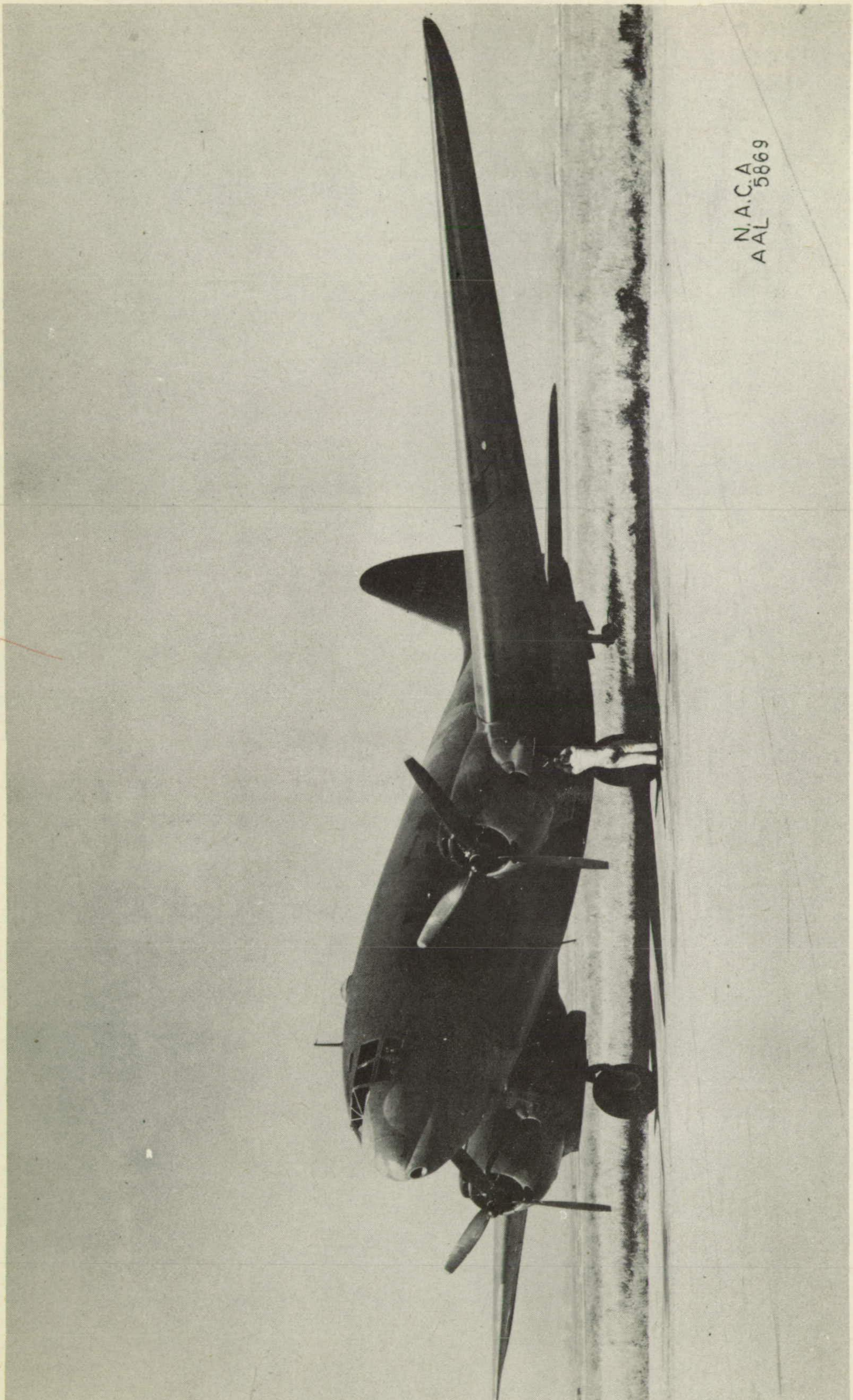


Figure 1.- The C-46 airplane equipped with thermal ice-prevention system.

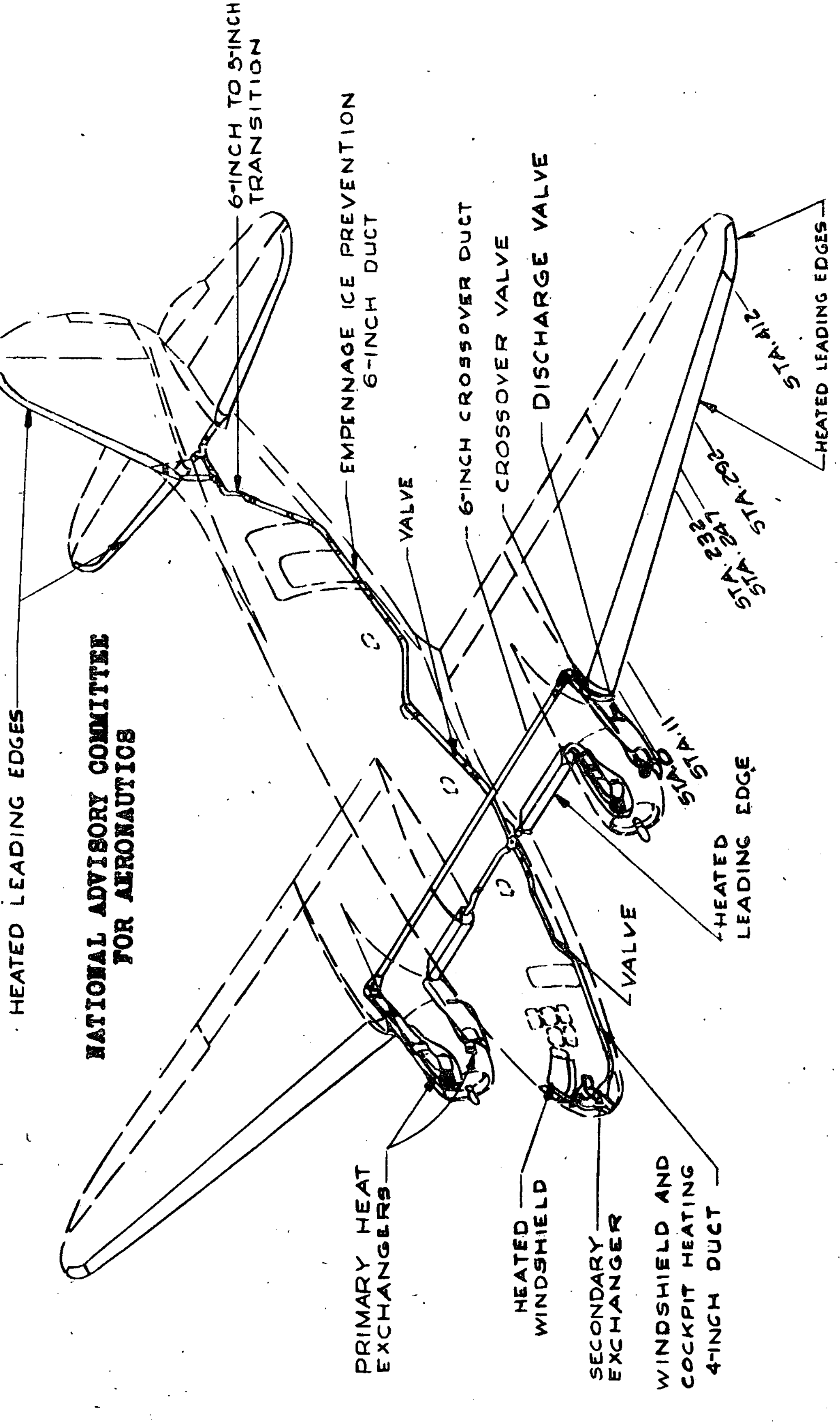
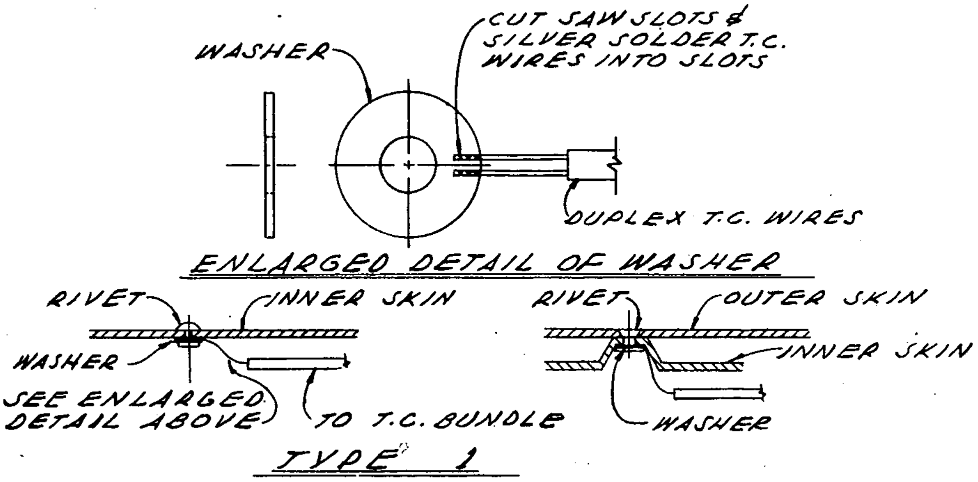
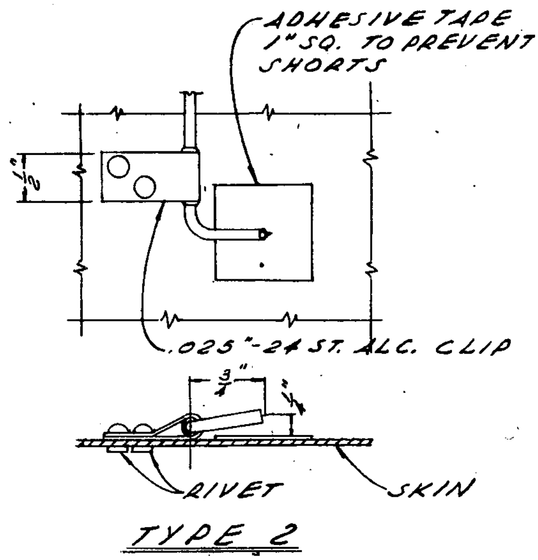


FIGURE 2.—GENERAL ARRANGEMENT OF THERMAL ICE-PREVENTION EQUIPMENT OF C-46 AIRPLANE



THERMOCOUPLES



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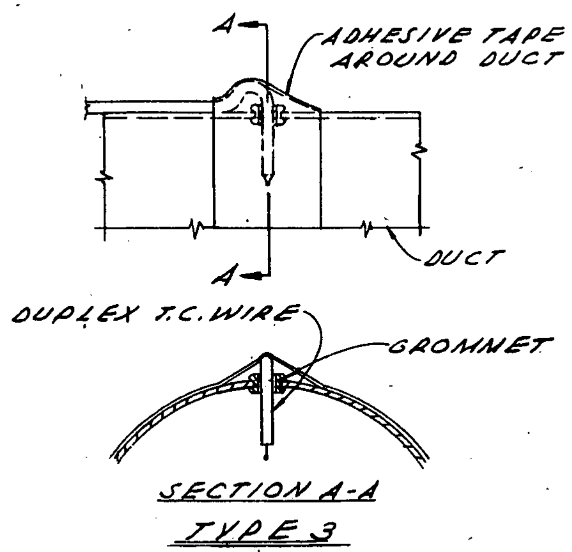

Figure 3 (a to c).- Types of thermocouples and pressure orifice installations used to determine performance of ice-prevention equipment of the C-46 airplane.

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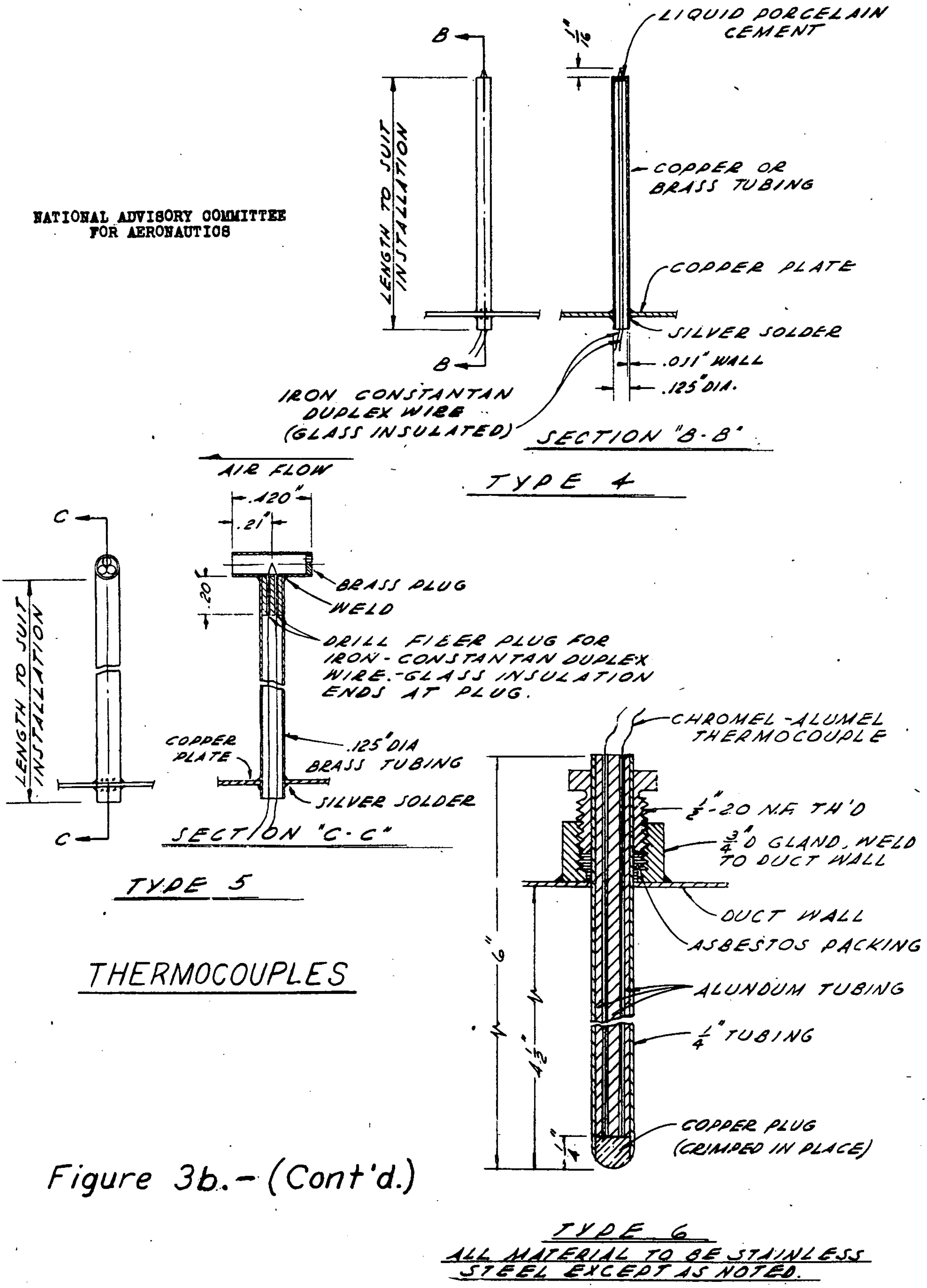
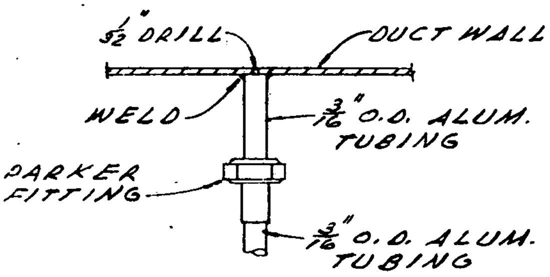


Figure 3b.- (Cont'd.)



TYPE 1

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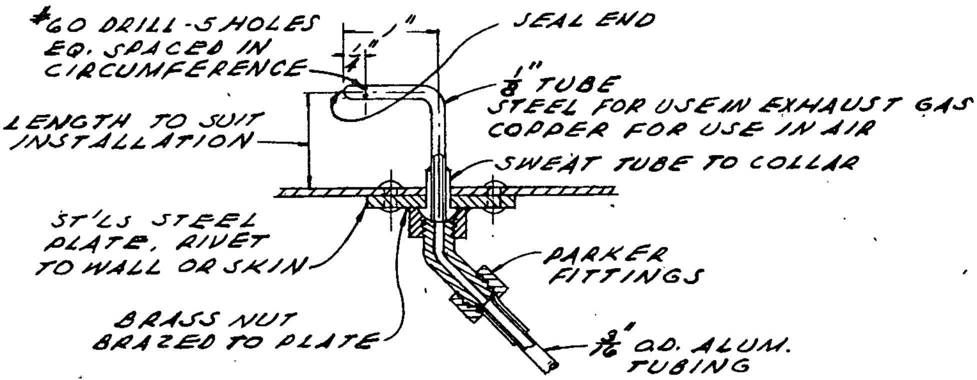
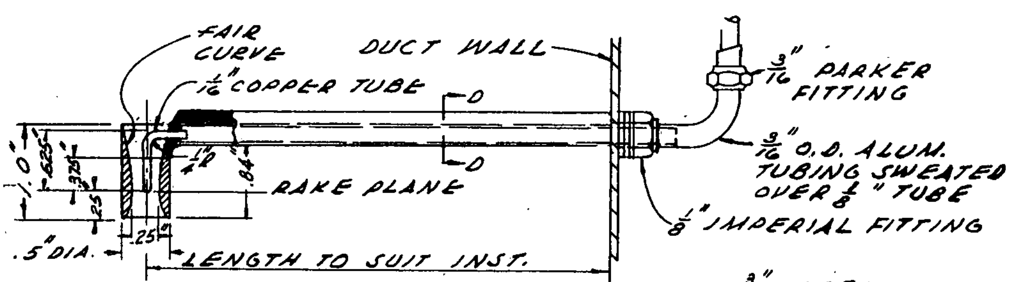
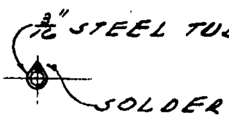


TYPE 2

PRESSURE ORIFICES



TYPE 3



SECTION "D-D"

Figure 3c.- (Concl'd.)

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FOR AERONAUTICS

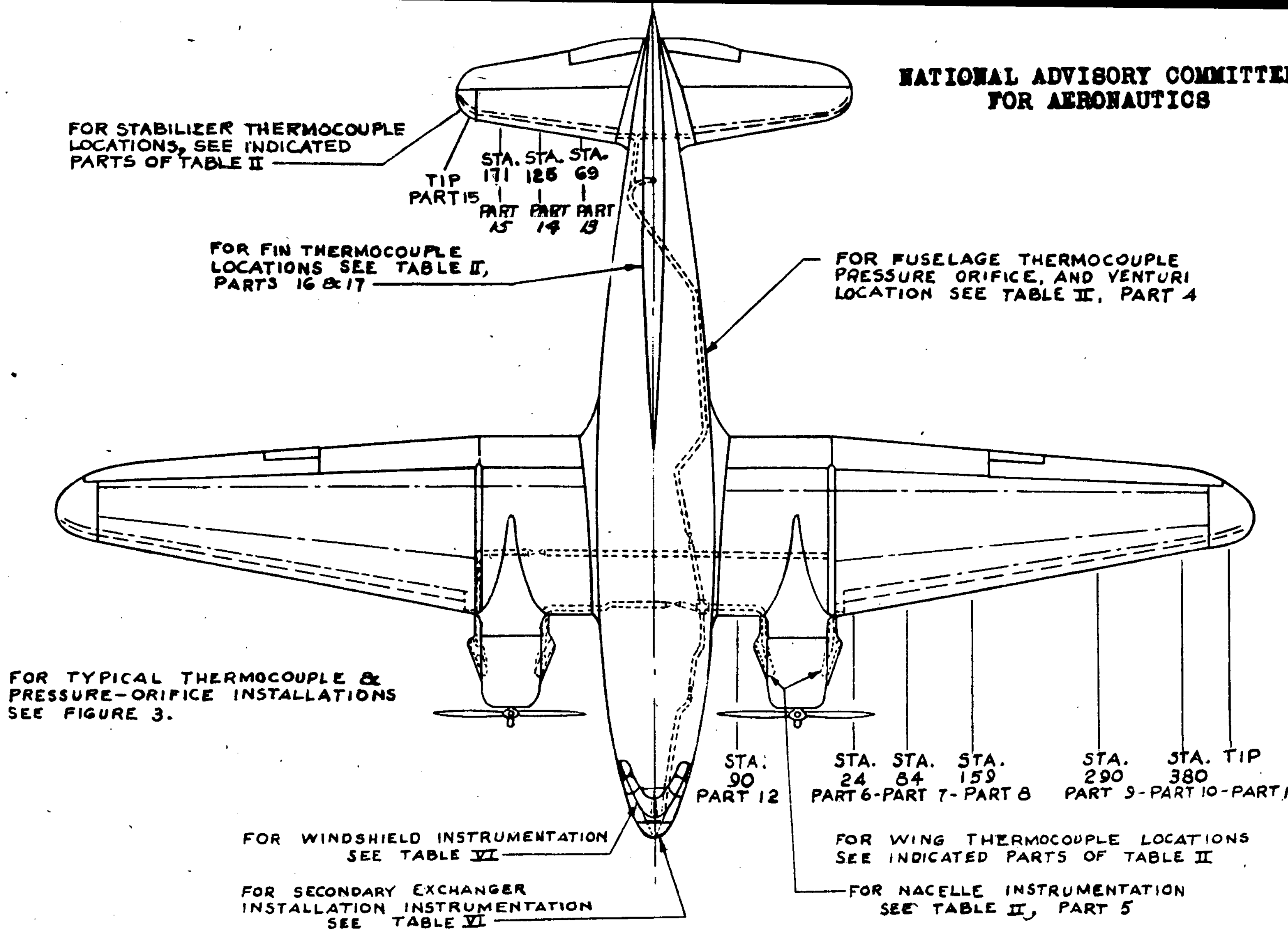

FIG. 4.- INDEX TO THERMOCOUPLE & PRESSURE-ORIFICE LOCATIONS ON C-46 AIRPLANE

Figure 5.- Ice allowed to accumulate on left wing outer panel and ice on cowl and carburetor air inlet, C-46 airplane. Flight 41. Photograph taken in flight.

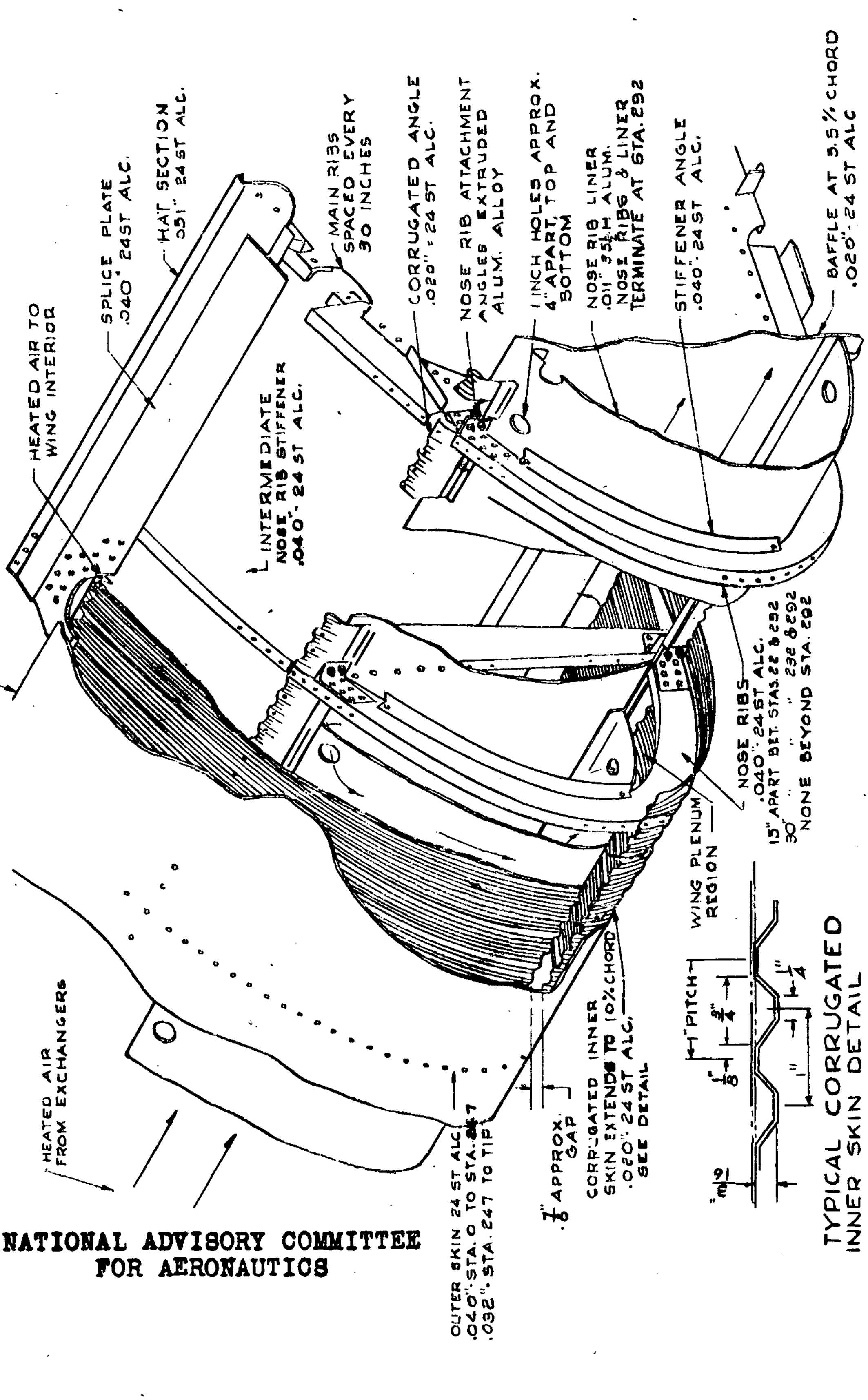

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FIGURE 6.- TYPICAL WING OUTER-PANEL LEADING-EDGE SECTION AS REVISED FOR THERMAL ICE PREVENTION, C-46 AIRPLANE

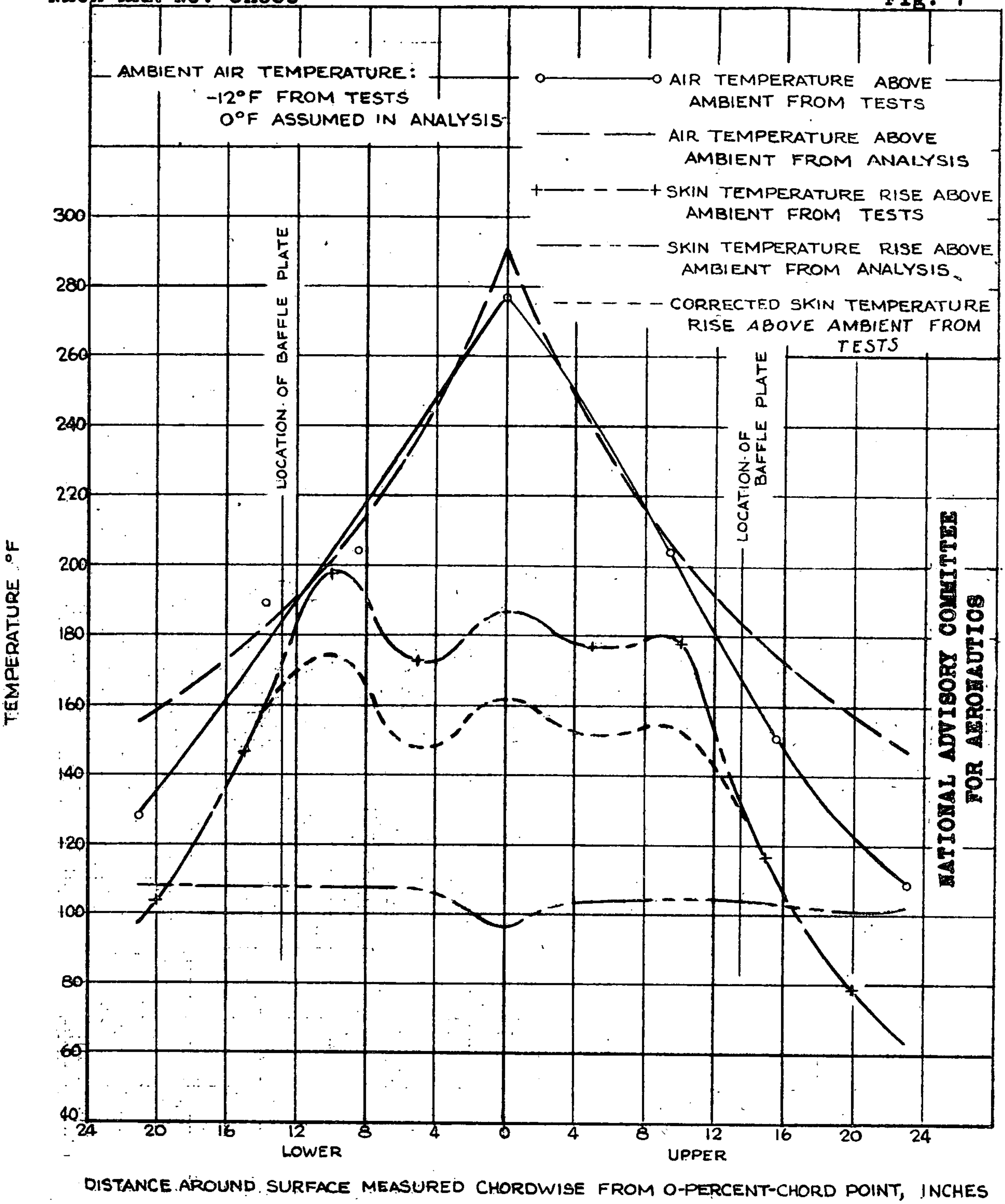

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FIGURE 7 - COMPARISON OF ANALYTICAL AND EXPERIMENTAL TEST RESULTS OF AIR-AND SKIN-TEMPERATURE RISES ABOVE AMBIENT-AIR TEMPERATURE FOR WING STATION 84, C-46 AIRPLANE.

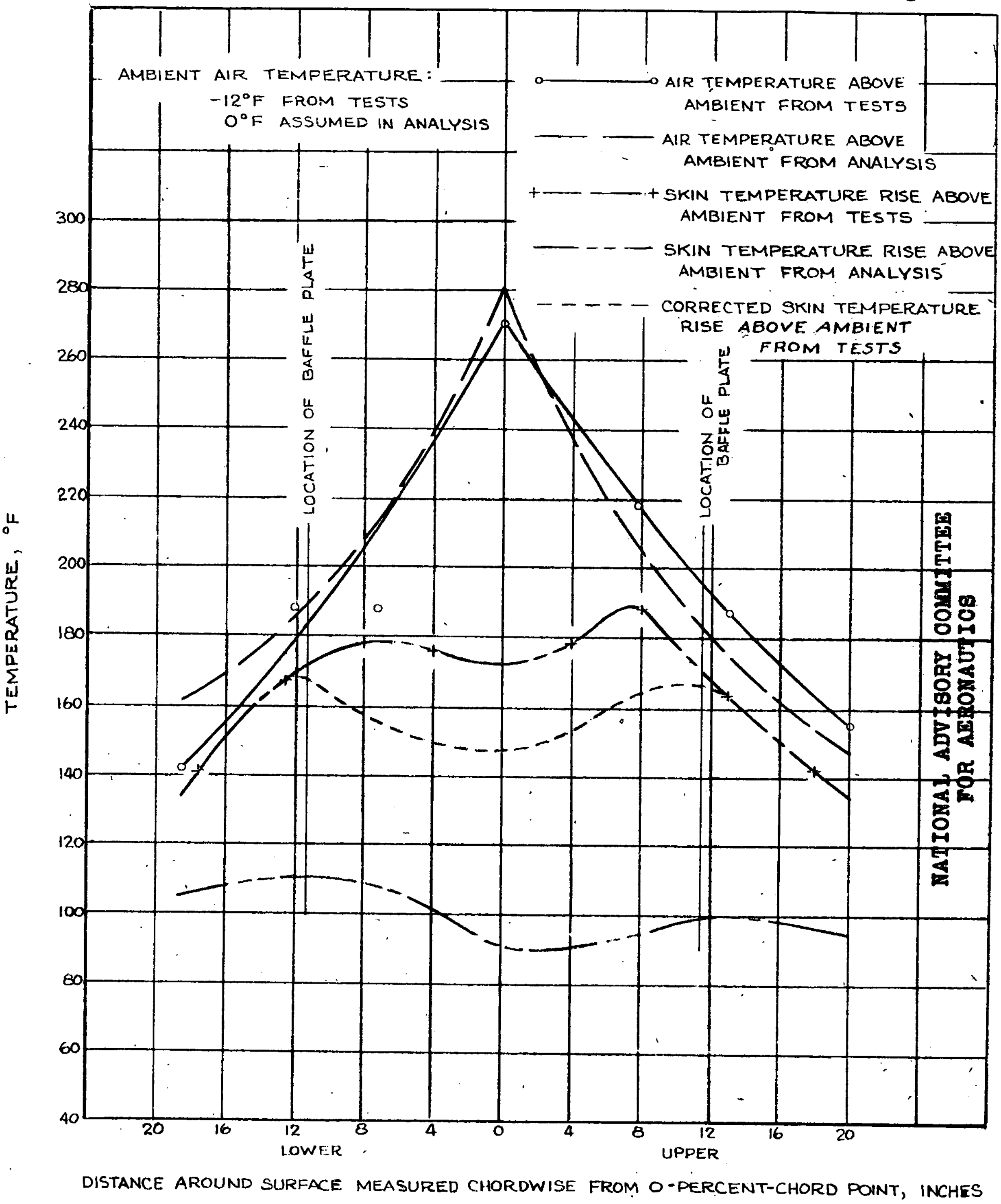


FIGURE 8.- COMPARISON OF ANALYTICAL AND EXPERIMENTAL TEST RESULTS OF AIR-AND SKIN-TEMPERATURE RISES ABOVE AMBIENT-AIR TEMPERATURE FOR WING STATION 159, C-46 AIRPLANE.

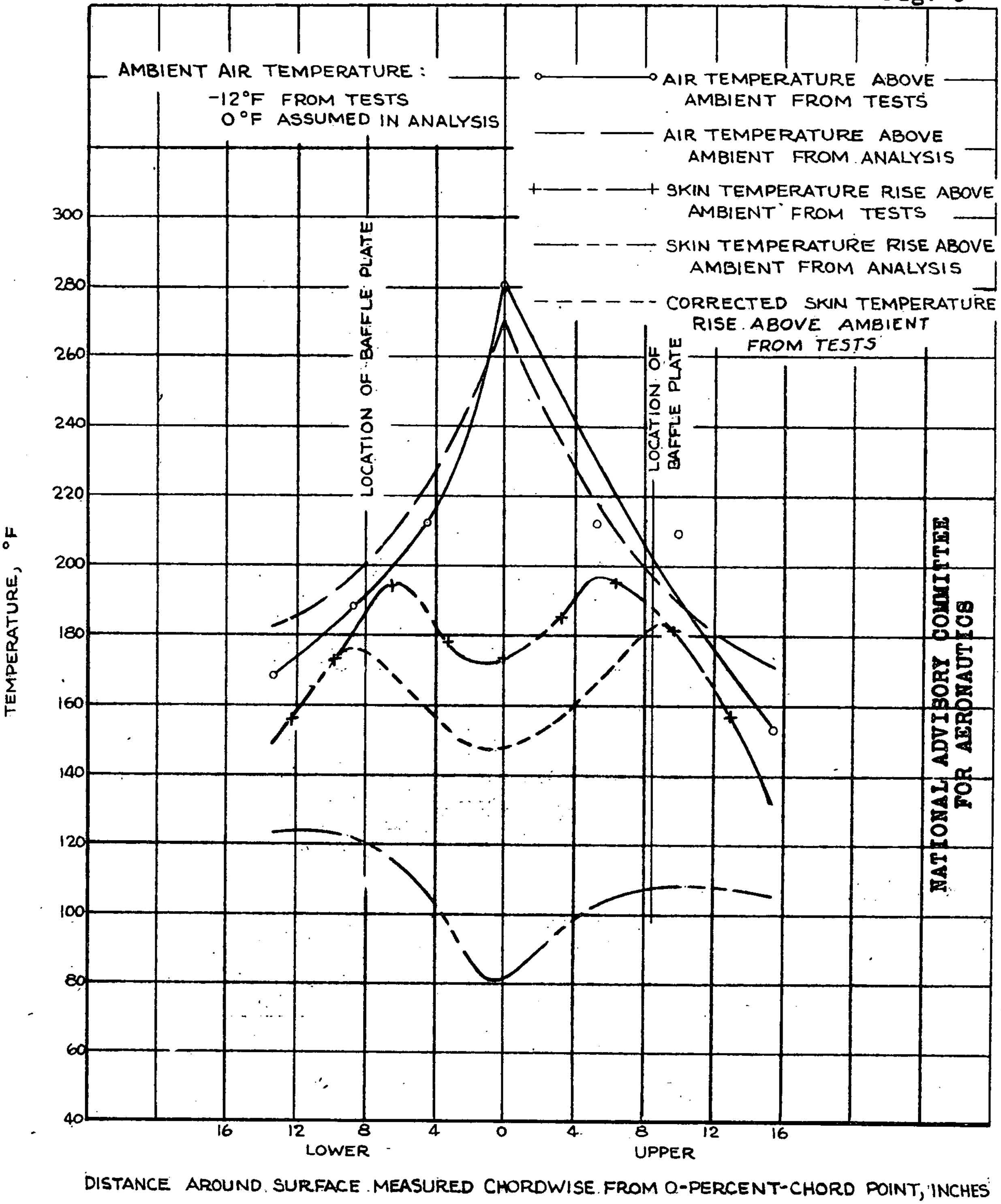


FIGURE 9 .- COMPARISON OF ANALYTICAL AND EXPERIMENTAL TEST RESULTS OF AIR-AND SKIN-TEMPERATURE RISES ABOVE AMBIENT-AIR TEMPERATURE FOR WING STATION 290, C-46 AIRPLANE.

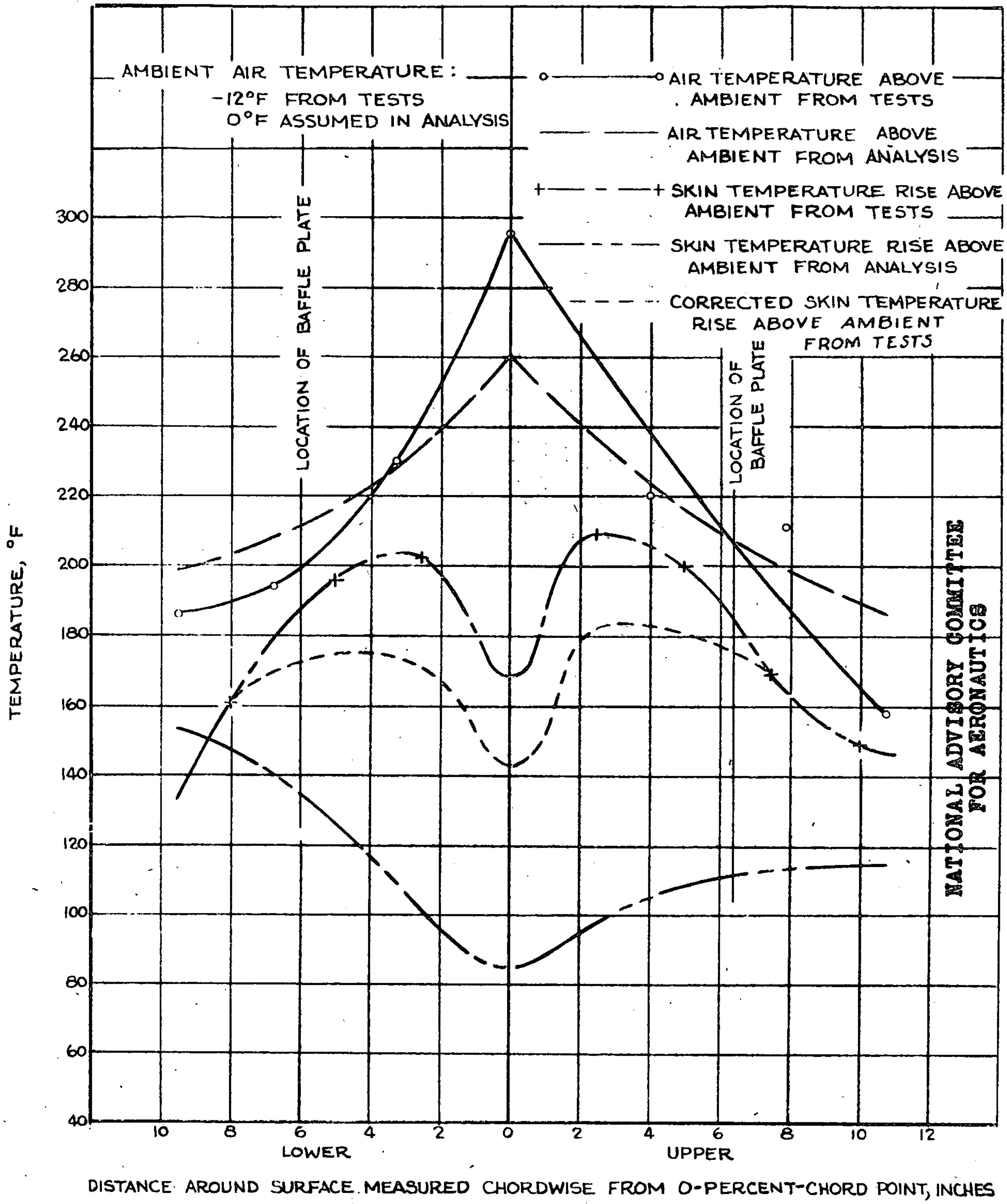


FIGURE 10. COMPARISON OF ANALYTICAL AND EXPERIMENTAL TEST RESULTS OF AIR-AND SKIN-TEMPERATURE RISES ABOVE AMBIENT-AIR TEMPERATURE FOR WING STATION 380, C-46 AIRPLANE.

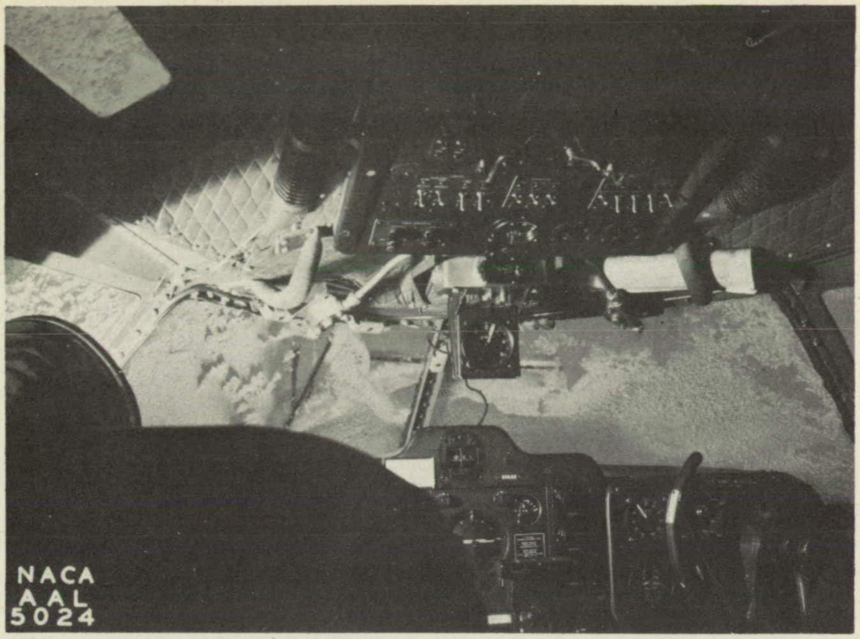


Figure 11.- Ice accumulation on pilot's and copilot's windshields after 45 minutes in heavy-icing conditions with only primary heated air directed over outside surfaces of windshields, C-46 airplane. Photograph taken in flight.

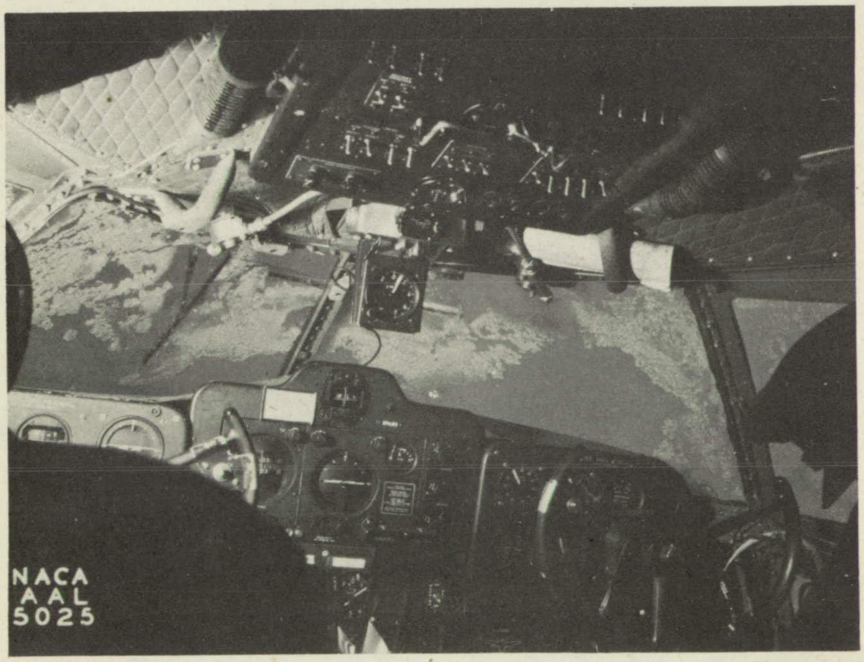


Figure 12.- Partial ice removal from pilot's and copilot's windshields with secondary heated air directed over the inside of the windshields without inserting double panels, C-46 airplane. Photograph taken in flight.

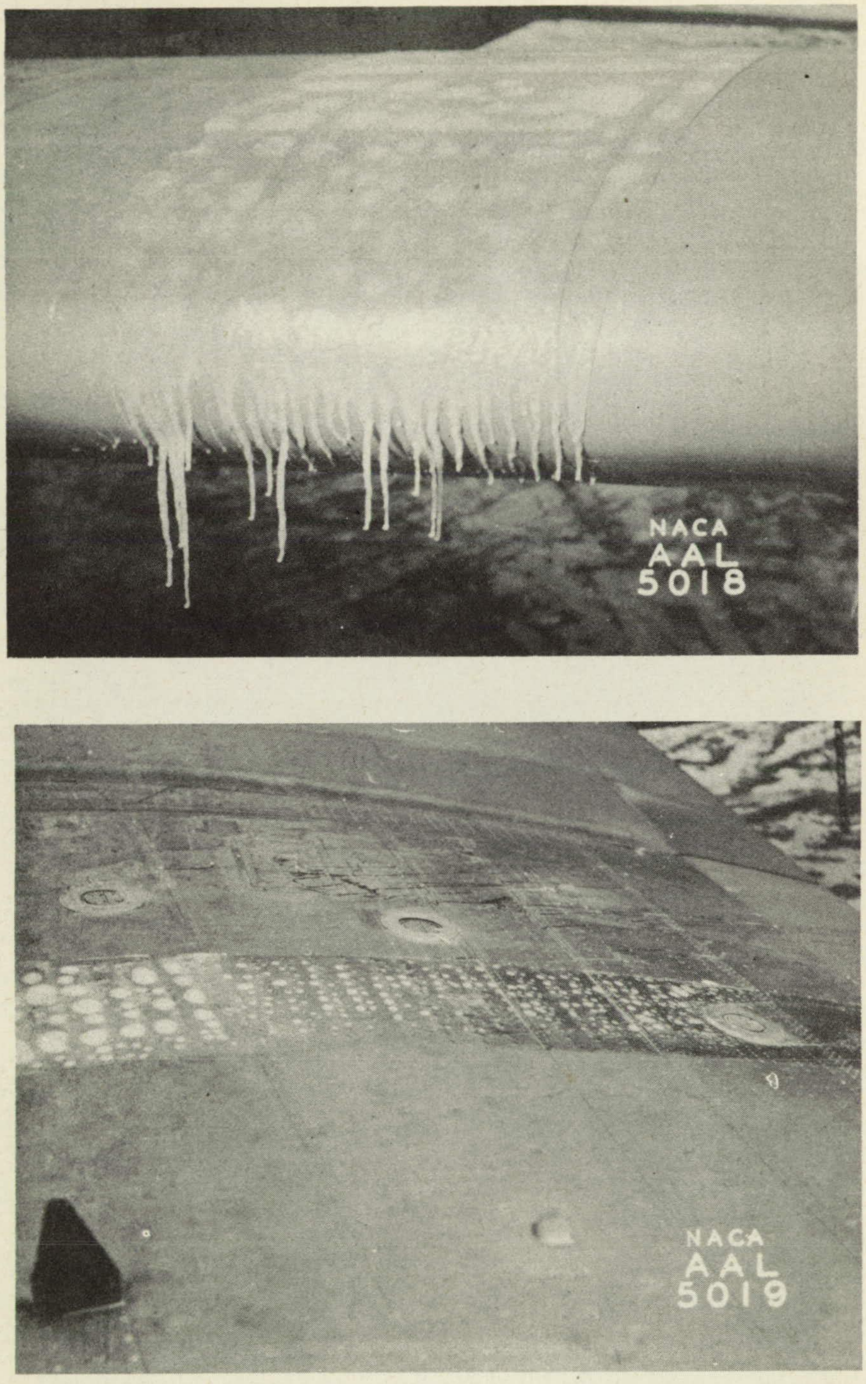


Figure 13.- Views showing the strip of ice applied to station 159 of the left wing outer panel for the simulated icing tests, C-46 airplane.

Figure 14.- Ice removed by engine warm-up and take-off in simulated icing tests, C-46 airplane.

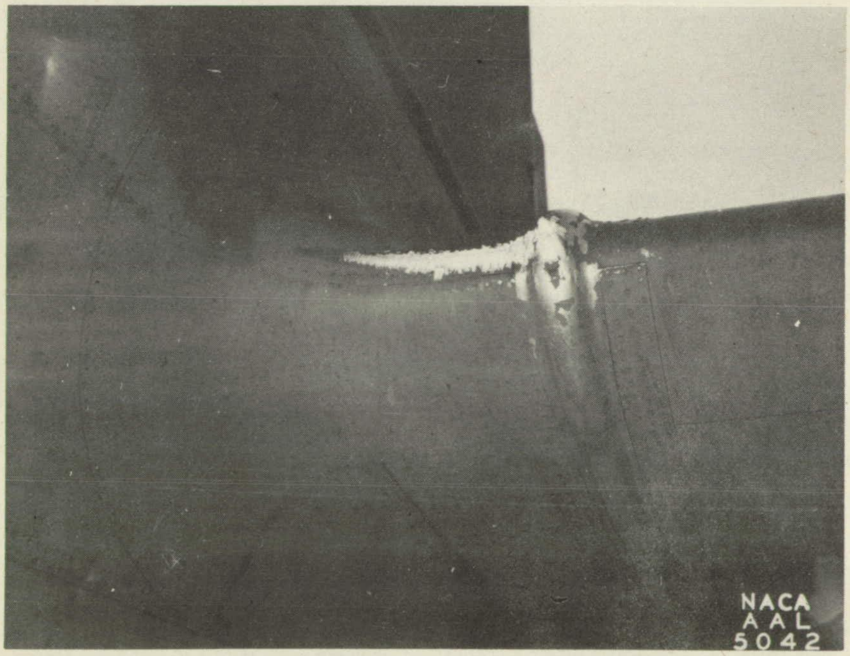


Figure 15.- Ice accumulation on the left stabilizer splice and fairing of the C-46 airplane. Flight 60. Photograph taken after landing.

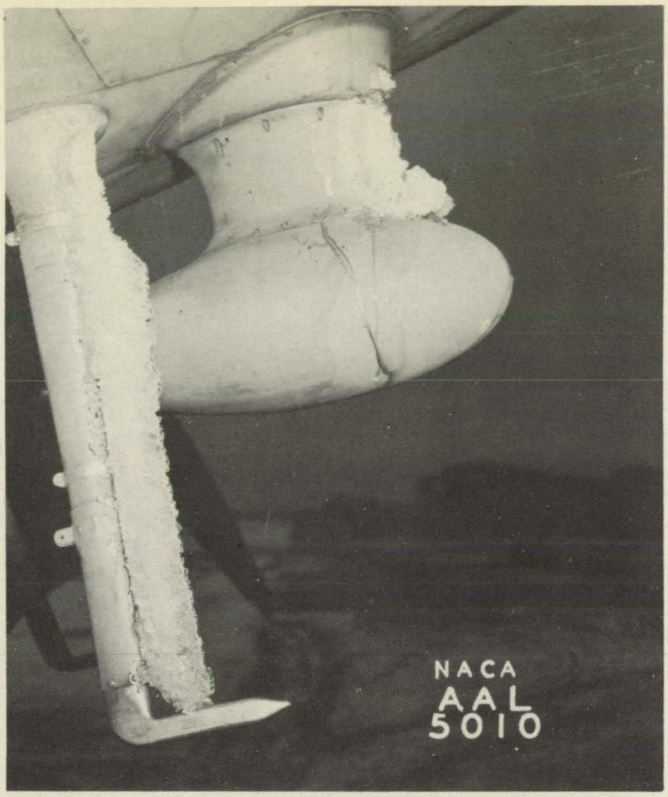


Figure 16.- Ice accumulations on the right airspeed mast and loop antenna of the C-46 airplane. Flight 29. Photograph taken after landing.

Figure 17. Ice accumulation on pilot's free air thermometer, C-46 airplane. Flight 29. Photograph taken after landing.

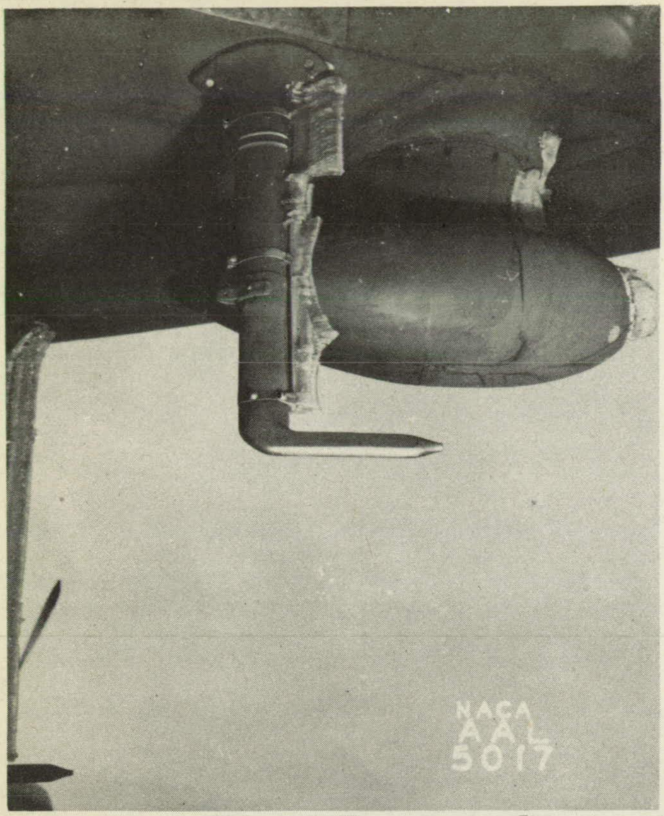


Figure 18.- Ice formations on the right airspeed mast and loop antenna and on the left airspeed mast of the C-46 air plane. Flight 41. Photograph taken after landing.

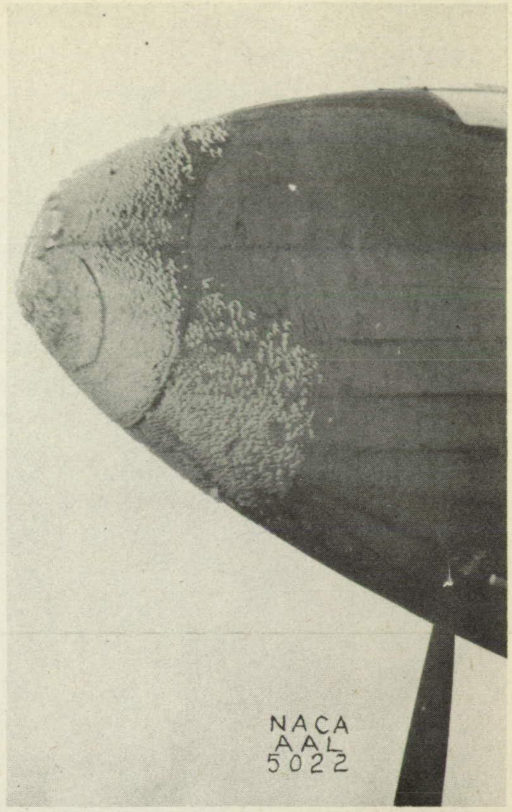


Figure 20.- Ice accumulation on the nose. Further extension of ice rearward had fallen off, C-46 airplane. Flight 50. Photograph taken after landing.

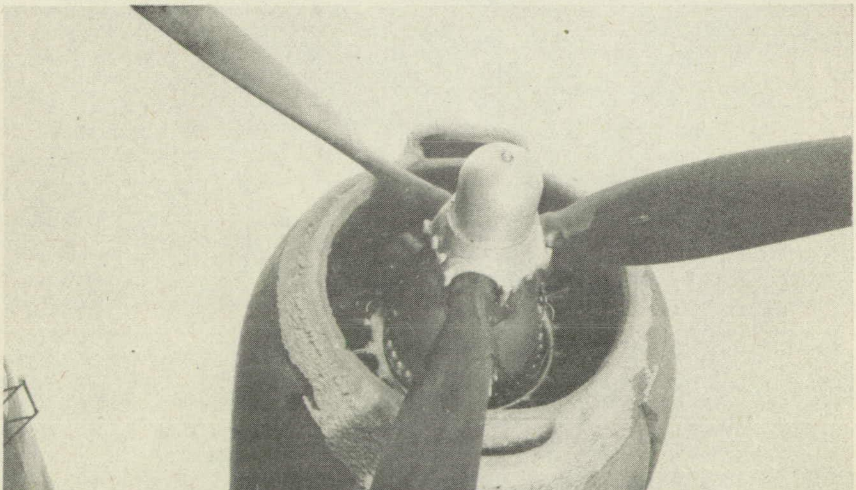


Figure 19.- Ice accumulation on the left engine cowl. Extension of ice around nacelle had fallen off, C-46 airplane. Flight 50. Photograph taken after landing.

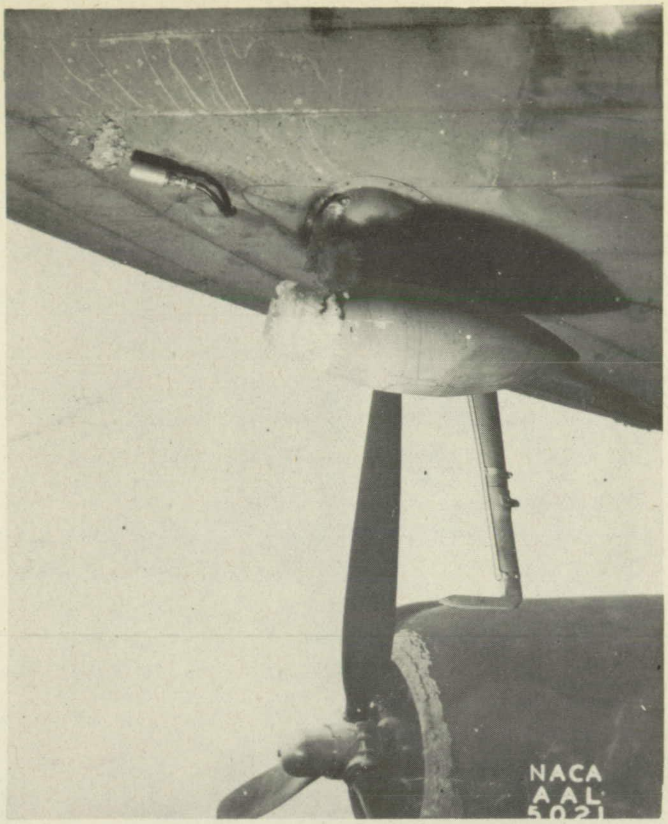


Figure 21.- Ice accumulatiom on the loop antenna, C-46 airplane. Flight 50. Photograph taken after landing.

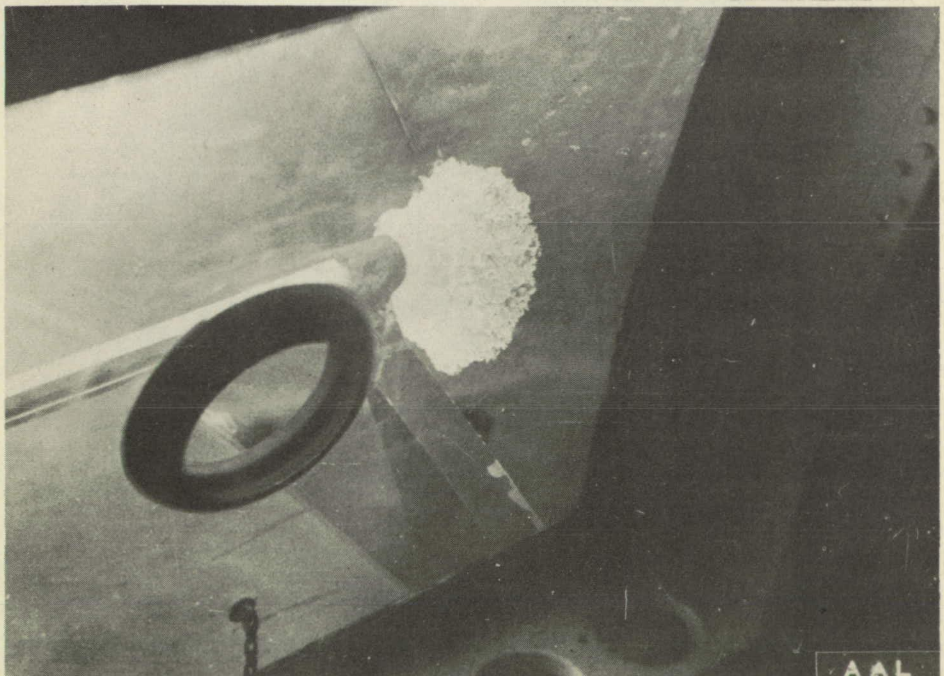


Figure 22.- Ice formation on the left-hand thermometer support, C-46 airplane. Flight 51. Photo graph taken in flight.

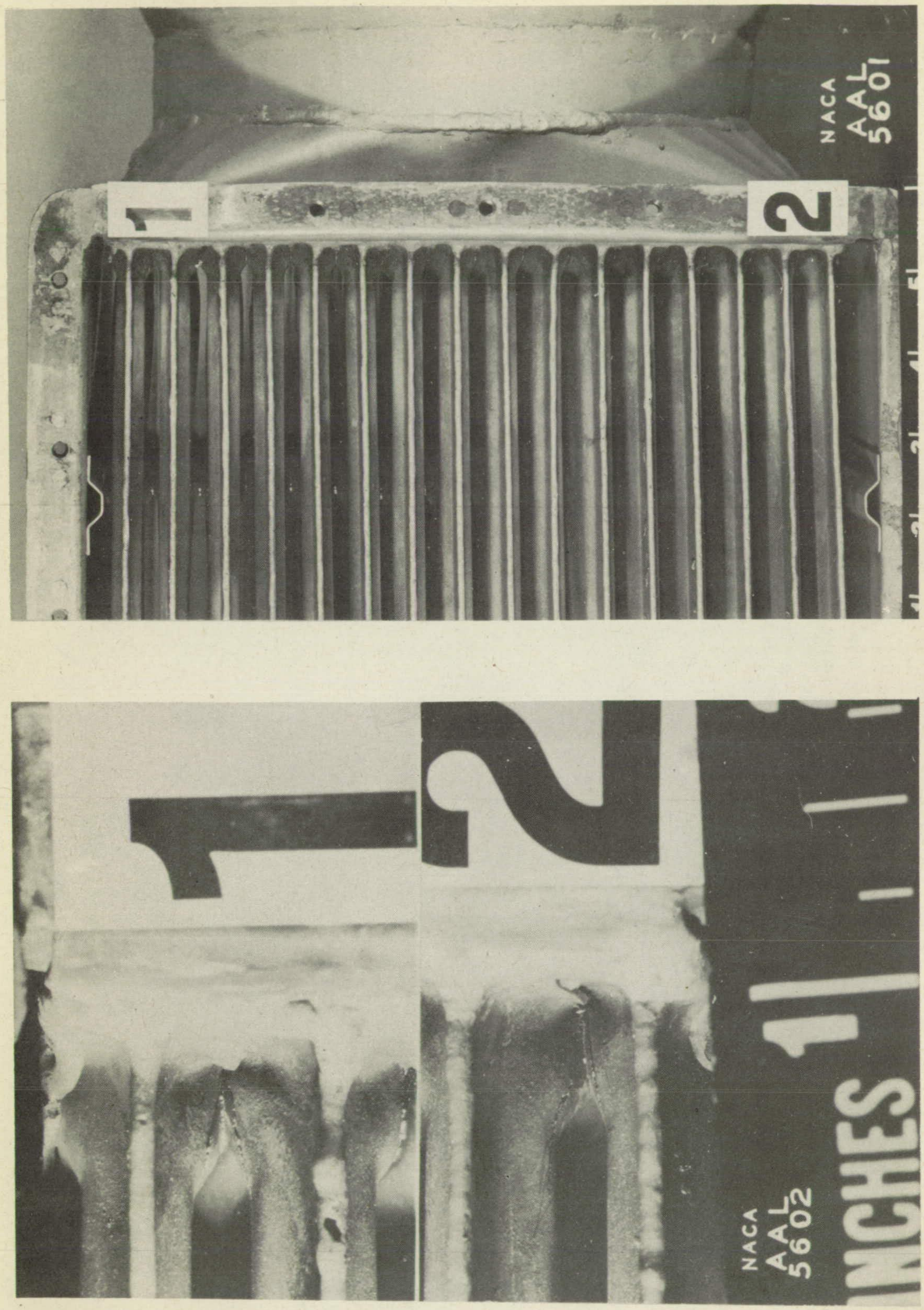
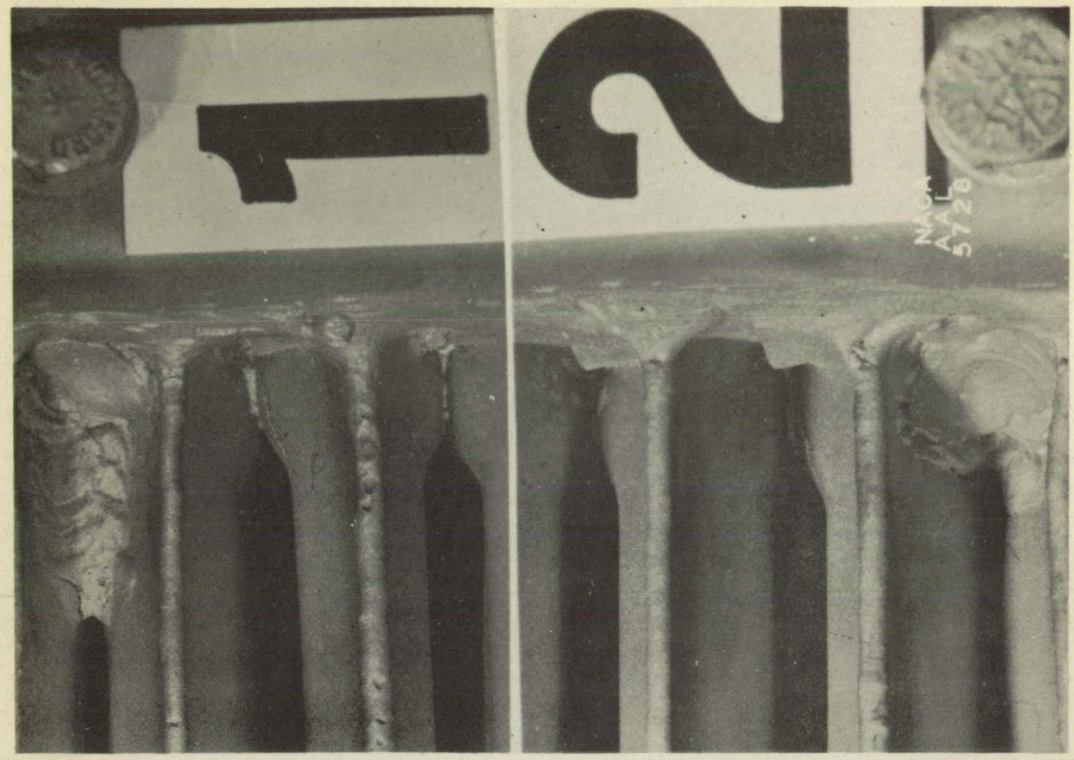


Figure 23.- Views showing air side of left inboard heat exchanger after 100 hours of flight testing, C-46 airplane.

Figure 24.- Left inboard heat exchanger after 100 hours of flight testing. Views showing gas-side cracks and shroud crack, C-46 airplane.



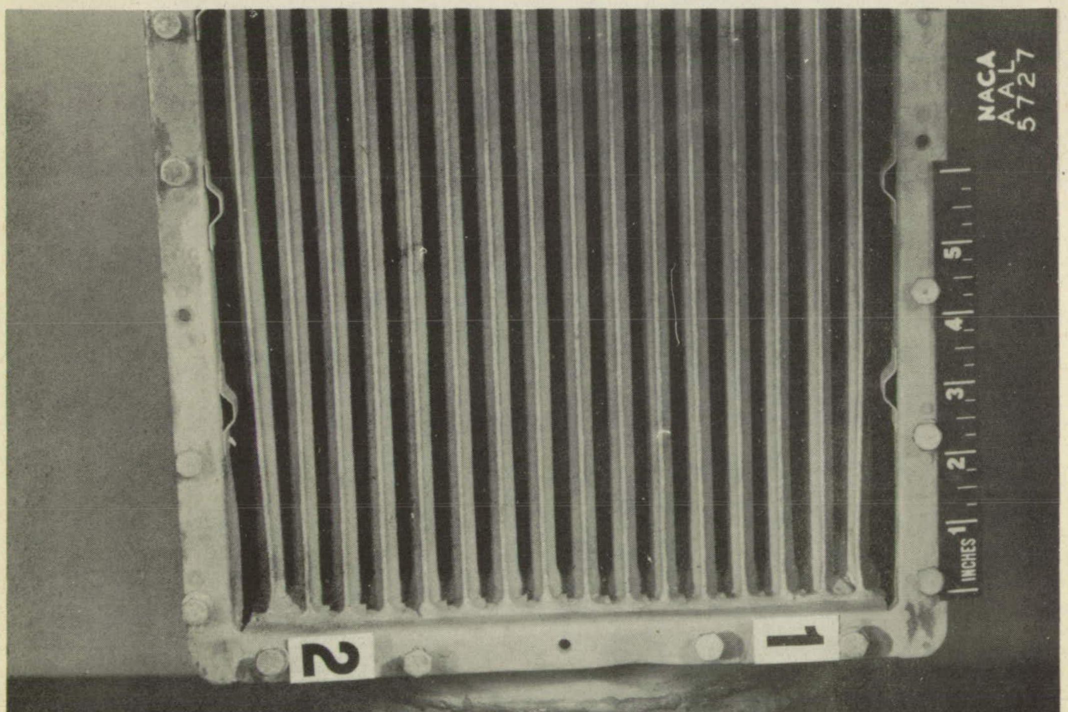
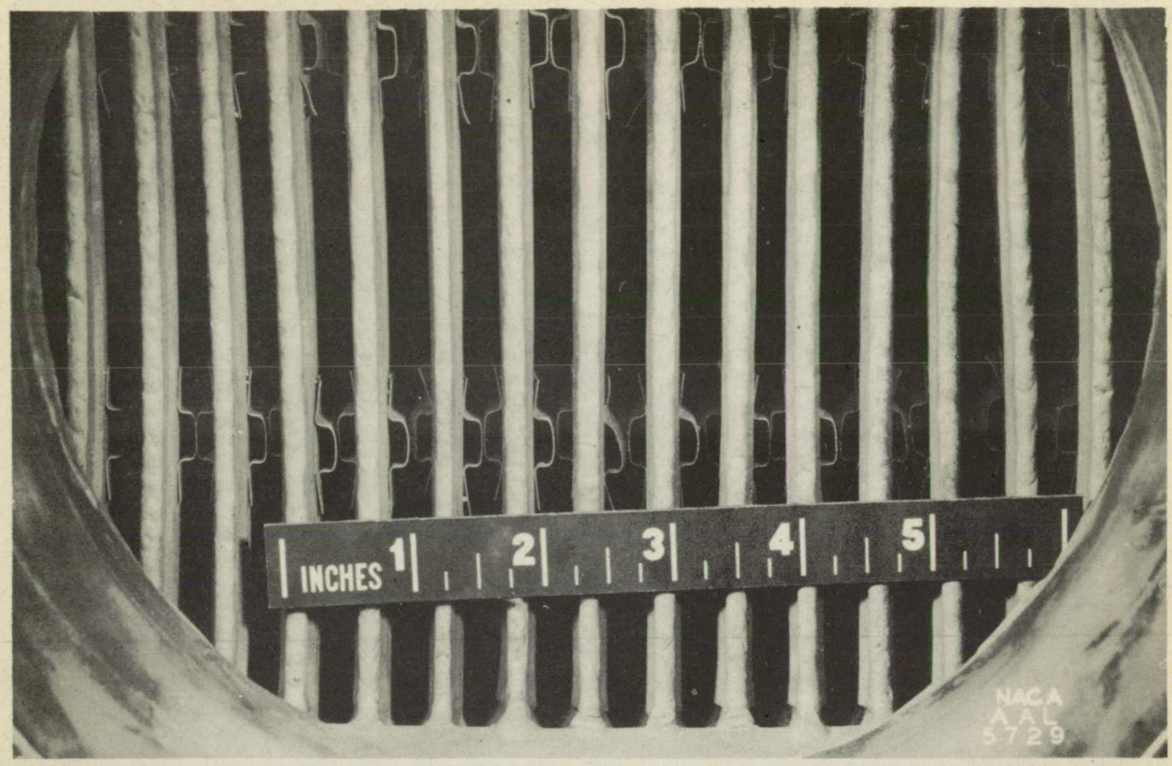


Figure 25.- Views showing air side of right inboard heat exchanger after 173 hours of flight testing, C-46 airplane.



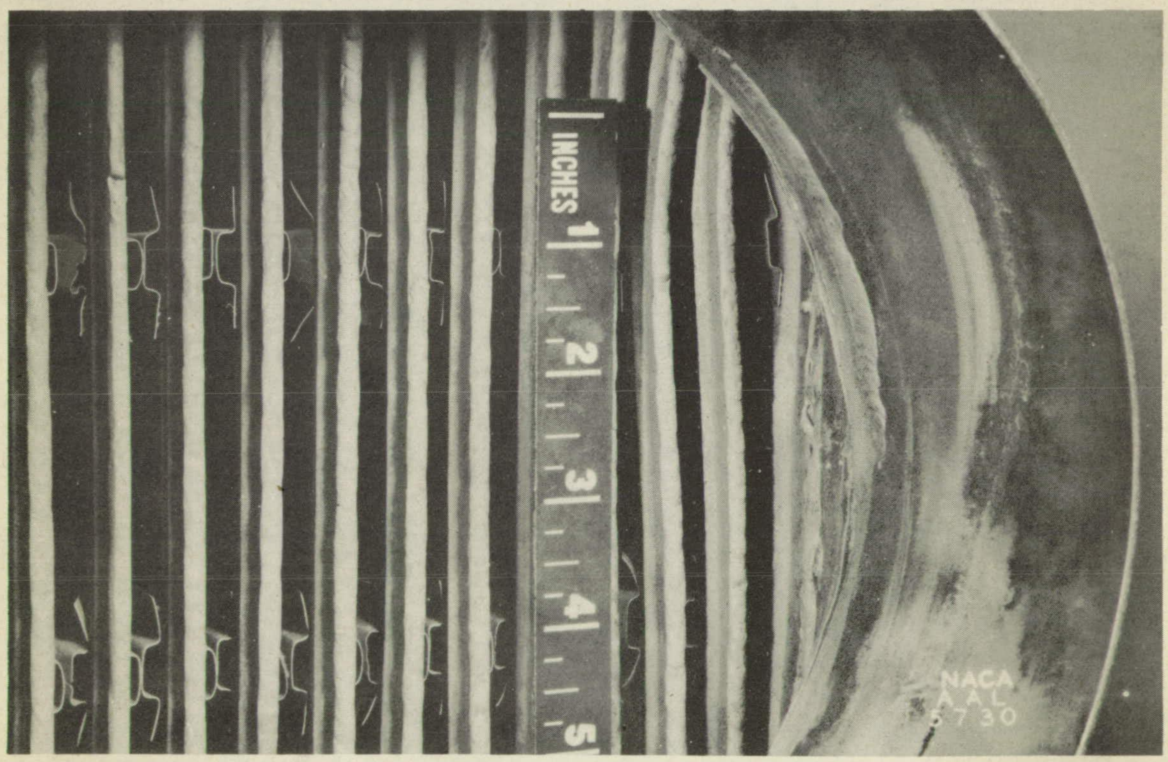


Figure 26.- Views showing exhaust-gas side of right inboard heat exchanger after 173 hours of flight testing, C-46 airplane.